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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE SAN DIEGO MEETING OF THE PACIFIC DIVISION

Edited by Professor J. MURRAY LUCK

STANFORD UNIVERSITY

THE twenty-second annual meeting of the Pacific Division, American Association for the Advancement of Science, and of twenty associated societies was held in San Diego, California, during the week of June 20, 1938.

It is no exaggeration to describe these meetings as probably the most successful in the history of the division. It may be recalled that the second meeting of the division some twenty-two years ago was held in San Diego with a total registration of 133. Since that time there has been a steady increase in the number of scientific organizations in the Pacific Coast states and of members in attendance upon the annual meetings. As an indication of the growth of interest in science on the Pacific Coast, it should be mentioned that the total registration of 832 members and guests established a new record.

The general sessions and the meetings of the participating societies were held in Balboa Park. The material facilities provided by the host institutions were excellent in every respect. Not only were the buildings in which the sessions were held conveniently grouped together and within easy reach of registration headquarters, but the luxuriant gardens of the park provided a setting of great beauty which added much to the pleasure of the visit in San Diego.

Six organizations joined in sponsoring the meeting and served as hosts to the visiting members and guests: San Diego Society of Natural History, Scripps Institution of Oceanography (La Jolla), San

Diego Museum Association, Zoological Society of San Diego, San Diego State College and the San Diego County Medical Society.

The local arrangements were in charge of a general committee, of which Clinton G. Abbott served as chairman. Not only did many residents of San Diego and its immediate vicinity assist greatly in organizing the meeting through service upon committees, but substantial material aid was extended by the San Diego Convention Bureau.

The first general session was held on the morning of June 21 and consisted of a symposium on "Climate and Man" in which four invited speakers participated. As an introduction to the symposium, "The Present Climate of California" was discussed by Professor John B. Leighly, of the University of California. "Climatic Variations" was the subject of the second address presented by Dr. Ernst Antevs, of Globe, Arizona. Dr. Merrill K. Bennett, of the Food Research Institute, Stanford University, gave an illuminating paper on "Climate and Agriculture," while the concluding address, "Sociological Aspects of Climate," was presented by Professor C. M. Reynolds, of the department of economics, Stanford University.

On the afternoon of the same day a session of considerable interest was held in which the progress of research in several fields was described. Dr. J. A. Anderson, of the Mount Wilson Observatory, Pasadena, described "Recent Instrumental Developments in Astronomy"; H. U. Sverdrup, director of the Scripps Institution of Oceanography (La Jolla), reported on "Recent Advances in Our Knowledge of the Oceans"; Professor C. H. Danforth, of Stanford University, reviewed certain aspects of current research on "The Sex Hormones," and Professor R. Goldschmidt, of the University of California, Berkeley, gave the concluding paper on "Genetics."

Addresses of general interest to the visiting members, as well as to the lay public, were presented on three evenings of the week. The first of these took the form of a symposium on "Animal Experimentation," in which B. O. Raulston, of the University of Southern California, A. J. Carlson, of the University of Chicago, and H. B. Torrey, of Stanford University, participated. The necessity of animal experimentation for future progress in biology and medicine was emphasized in these addresses. Dr. Raulston presented "The Clinical Point of View," Professor Carlson, "The Laboratory Point of View" and Professor Torrey, "The Biologists' Point of View." The subject of this symposium proved to be of considerable interest to the public and very appropriate for consideration at the present time in view of the forthcoming referendum in California upon the so-called "Humane Pound Act," the effect of which would be to render almost impossible the use of dogs and cats for experimental purposes.

Dr. J. S. Plaskett, of the Dominion Astrophysical Observatory, Victoria, B. C., as president of the division, gave the second public address of the week on "Modern Conceptions of the Stellar System." The third and concluding address was presented on June 23 by Professor C. Skottsberg, of the Botanical Garden, Gothenburg, Sweden, on "The Distribution of Flowering Plants over the Pacific Ocean and its Significance."

Among the events of a social character arranged for the entertainment of visiting members and guests, mention should be made of a general reception which was tendered by the host institutions on the afternoon of June 21. This was held in the beautiful gardens of the Court of Honor, Balboa Park. On the afternoon of June 22, tea was served by the San Diego Branch of the American Association of University Women in the Loggia of the House of Hospitality, and again on the afternoon of June 23 in the Fine Arts Gallery by the director and staff.

A number of attractive excursions were arranged, among which mention might be made of those to San Diego Gardens and the Hotel del Coronado, to the San Diego Zoological Gardens, to Point Loma and Old Town, to the Torrey Pines Park and the Scripps Institution of Oceanography, and finally, more extensive trips to Palomar Mountain and the new observatory now under construction by the California Institute of Technology.

Meetings of the executive committee were held daily and of the council on June 22. Dr. S. J. Holmes, professor of zoology at the University of California, Berkeley, was elected to the presidency of the Pacific Division for the ensuing year. H. S. Reed, professor of botany, University of California, Berkeley, was elected to the executive committee in succession to A. R. Davis on completion of the customary five-year term of office. Professor T. G. Thompson, of the University of Washington, Seattle, who had just completed a term of office of three years as a member of the executive committee, was reelected for a full five-year term.

The following eight fellows of the association were elected as members-at-large to serve upon the council: Professor C. H. Thienes, department of pharmacology, University of Southern California (one-year term); Professor E. B. Babcock, department of genetics, University of California, Berkeley (one-year term); Dr. F. J. Veihmeyer, division of irrigation, University of California, Davis (two-year term); Professor C. McLean Fraser, department of zoology, University of British Columbia, Vancouver, B. C. (two-year term); Professor A. P. Krueger, department of bacteriol-

ogy, University of California, Berkeley, three-year term); Professor Max Mason, department of mathematics, California Institute of Technology, Pasadena (three-year term); Professor C. L. Utterbach, department of physics, University of Washington, Seattle (four-year term), and Dr. H. A. Spoehr, director, Carnegie Institute of Plant Biology, Stanford University (four-year term).

The following resolution on the so-called "Humane Pound Act" was adopted by the council:

WHEREAS, Our past impressive achievements in the cure and prevention of disease throughout the world have resulted from an intelligent understanding of the functions of the human and animal body in health and disease, and

WHEREAS, The very imperfect advance of our race from savagery and superstition has depended and will continue to depend in no small measure upon a steady increase in our knowledge of the life processes of living beings, both plant and animal, and

WHEREAS, An important part of such knowledge can only be obtained by the actual study of living animals by experimental methods, humanely conducted, and

WHEREAS, An active but misinformed minority of our citizens has persistently refused to recognize the source of these discoveries though ever willing to benefit from them and has continually charged our leading medical and biological authorities with inflicting cruelty upon animals, and has endeavored to hamper these persons by legislation and otherwise, and

WHEREAS, A measure is to be placed upon the ballot next November, and voted upon by the people of California, which purports to be a humane measure, designed to protect from mistreatment animals in public pounds, but whose real effect would be to seriously handicap important and necessary research, and

WHEREAS, The enactment of such legislation would be to greatly retard the progress of biological and medical research in this state,

Therefore, be it resolved by the American Association for the Advancement of Science, Pacific Division, assembled in San Diego in June, 1938, that the Division strongly urges the defeat of the so-called "Humane Pound Act" and recommends the employment of widespread publicity calculated to achieve this end.

Announcement was made that the 1939 meeting of the division would be held at Stanford University from June 26 to July 1, 1939, and that of 1940, which will be national in character, will be at the University of Washington, Seattle.

SESSIONS OF THE AFFILIATED SOCIETIES

Twenty of the affiliated and associated societies participated in the meetings and over three hundred papers were presented. The reports of the various sessions follow:

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS, PACIFIC SLOPE BRANCH

(*Report by J. F. Lamiman*)

The Pacific Slope Branch of the American Association of Economic Entomologists held its twenty-third annual meeting on Thursday and Friday, June 23 and 24. During the sessions twenty-two papers were presented. These dealt with a wide range of entomological subjects, including insect toxicology and evaluation of field data.

The entomologists' dinner was held on Thursday evening, and the members were addressed by J. J. Davis and J. A. Hyslop.

The total attendance at the meetings was seventy-two.

The officers elected for 1938 are: *Chairman,* R. H. Smith, University of California at Los Angeles; *Vice-Chairman,* B. G. Thompson, Oregon State College; *Secretary-Treasurer,* J. F. Lamiman, University of California, Davis, California.

AMERICAN CHEMICAL SOCIETY, PACIFIC INTERSECTIONAL DIVISION

(*Report by William G. Young and Dudley H. Robinson*)

The opening session on Wednesday morning was devoted to contributed papers in organic and biological chemistry. Two interesting papers were presented on physical and chemical tests for freshness of fish for food. One group of papers dealt with physiological activity of vitamin C and of vitamin-B_2 analogs and with the synthesis of compounds possessing vitamin-B_2 activity by the pea root. Another group dealt with rearrangements during the synthesis of stereoisomeric compounds.

Wednesday afternoon was given over to an invited group of papers of general interest. Professor A. O. Beckman, of the California Institute of Technology, discussed difficulties encountered in the use of the glass electrode. Professor M. S. Dunn, of the University of California at Los Angeles, presented results on the physical and chemical properties of the amino acids. Professor C. R. Noller, of Stanford University, discussed the structural chemistry of the saponins and sapogenins from the California soap root, while Professor Roger J. Williams, of Oregon State College, summarized his work on the chemical nature of pantothenic acid. Professor Don M. Yost, of the California Institute of Technology, concluded the session with a paper on "Artificial Radioactivity and its Chemical Applications." All the papers were interesting, and an active discussion followed each of them.

The Thursday morning and afternoon sessions were devoted to physical and inorganic chemistry. A number of papers on colloidal and surface chemistry were presented by investigators from Stanford University. An exhibit of several types of inexpensive air-driven ultracentrifuges attracted particular attention. Another group of papers on the determination of molecular structure by x-ray and electron-diffraction methods

were presented by investigators from the California Institute of Technology.

Other papers included micro-qualitative analysis of the alkaline earths, polarographic investigations, photochemical oxidation of crotonaldehyde, efficiency of reduction by zinc amalgams and xanthates as collectors in ore flotation.

A dinner for chemists was held on Wednesday evening, and Professors F. O. Koenig, of Stanford University, and H. V. Tartar, of the University of Washington, were elected as members of the executive committee of the Pacific Intersectional Division of the American Chemical Society.

American Meteorological Society

(Report by Geo. F. McEwen)

The program of the American Meteorological Society concerned four groups of subjects: (1) Fog, clouds, minimum temperatures and dew points; (2) Weather conditions in relation to forest-fire danger and desert rainfall; (3) Comparative data on Southern California floods based upon official instrumental observations and historical research using old manuscript and published reports; (4) Methods of making upper air observations by means of small portable equipment that can be carried by a pair of sounding balloons. Dynamical treatment of certain upper air observations for calculating the wind velocity at various levels.

Encouraging progress has been made in using not only base station observations but also those from the fine networks of stations in regions of citrus cultivation supplemented by studies of general weather maps, for forecasting minimum temperatures on the afternoon of the preceding day. Methods of forecasting the formation and dissipation of fog and clouds are being developed along quantitative thermodynamical lines using diagrams and tables for facilitating computations. Such results are of special importance to naval operations in the Pacific.

Studies of compilations of numerous observations of wind temperature and humidity and the amount of moisture in inflammable forest material, determined from standard test strips of wood, have made it possible to construct charts invaluable to the forester in efficiently preventing forest fires and in fighting those that do occur.

Studies of available official instrumental observations and older historical records, carefully appraised, indicate several storms in the Los Angeles area comparable with those of February and March, 1938. Certain grossly inaccurate reports have been accepted and recopied as correct, even though a critical study failed to reveal convincing evidence of their correctness. Such research work, leading to tested conclusions and the elimination of unreliable statements, is being continued and should be encouraged.

Remarkable progress, especially since 1930, has been made in developing a small combination of radio transmitter, clock and storage battery, light enough to be carried by a pair of sounding balloons. Thus, essential upper air data on winds, temperature and humidity at heights up to about ten miles can be obtained during nearly all weather conditions and without making aeroplane flights.

Not only instrumental technique has improved but theoretical methods of dealing with upper air data have been developed, enabling the calculation of winds from more or less incomplete observations.

American Physical Society

(Report by Paul Kirkpatrick)

The Wednesday morning session was devoted to the presentation of brief contributed research reports of theoretical and experimental investigations of the properties of nuclear and cosmic ray particles, phenomena of gaseous ions and certain biophysical phenomena, including the effects of low temperatures upon living cells. This program was followed on Wednesday afternoon by a symposium on "Nuclear Transformations and their Astrophysical Significance," a joint session of the American Physical Society and the Astronomical Society of the Pacific at which W. A. Fowler spoke on "Nuclear Reactions as a Source of Energy," J. R. Oppenheimer upon "The Physical Problem of Stellar Energy" and R. Minkowski upon "The Composition of Stellar Atmospheres."

Contributed research reports constituted the program of the Thursday morning session, with problems of x-ray absorption and electron emission, sound absorption, atomic spectra, gaseous conduction, induced radioactivity and experimental techniques under consideration. The Thursday afternoon program, held at the Scripps Institution of Oceanography, comprised a symposium upon "The Physical Problems of the Ocean," a title comprehending questions of sand movemovement, sedimentary distribution, turbulence and suspension of small particles. This symposium was addressed by H. U. Sverdrup, F. P. Shepard, R. Revelle, W. E. Allen, G. F. McEwen and R. D. Gordon.

The final session, held on Friday morning, consisted of a series of contributed research reports treating the characteristics of certain research instruments (including one for objective determination of photographic graininess), a method for separating radioactive isotopes, emission of electrons under the action of electrostatic fields, variations in liquid viscosities due to flow orientation of molecules and the possible localization of the source of night-sky light in lower regions of the terrestrial atmosphere.

American Phytopathological Society
Pacific Division

(Report by L. D. Leach)

The Pacific Division of the American Phytopatho-

logical Society held three half-day sessions for the presentation of papers. About forty-five pathologists attended, and twenty-six papers were presented. The first half-day was devoted, mainly, to papers on diseases of citrus, among the most interesting of which were the reports by H. S. Fawcett and L. Klotz on the types and symptoms of psorosis and on its transmission.

The Tuesday afternoon program consisted of a series of papers on virus diseases. Of special interest to those in attendance was the report of Eubanks Carsner on the present status of resistance in sugar beets to curly top disease, that of N. J. Giddings on sugar-beet curly top virus strains, and C. W. Bennett's discussion of the movement of the virus of sugar-beet mosaic.

Other papers that attracted considerable interest were those by C. H. Spiegelberg on the pink disease of pineapple and by L. C. Cochran and Lee M. Hutchins on the host relationships of peach mosaic in Southern California.

Wednesday afternoon was devoted to excursions in the vicinity of San Diego. The largest group visited the Scripps Institution of Oceanography at La Jolla.

A short informal symposium on the teaching of plant pathology was held on Thursday afternoon. The same topic has been suggested for a more elaborate program during the next annual meeting.

Officers elected for the ensuing year are as follows: *President,* W. T. Horne, University of California; *Vice-president,* B. F. Dana, U. S. Department of Agriculture; *Secretary-Treasurer,* L. D. Leach, University of California, Davis; *Councilor,* E. Carsner, U. S. Department of Agriculture.

American Society of Ichthyologists and Herpetologists, Western Division

(*Report by Margaret Storey*)

More than twenty members and guests met informally at the laboratory and home of Laurence M. Klauber on Friday afternoon and visited his unsurpassed collection of southwestern rattlesnakes and other herpetological specimens. On Saturday a night desert collecting trip arranged by C. B. Perkins, of the San Diego Zoo, yielded eleven live lizards of two species and twenty-three live snakes of seven species in four hours in the vicinity of The Narrows. In addition, fourteen snakes of ten species and two lizards were observed run over on the road. Some of these were in sufficiently good condition to be saved. The National American Society of Ichthyologists and Herpetologists meeting at Berkeley from July 20 to 23 prevented official participation in the American Association for the Advancement of Science meetings this year.

American Society of Plant Physiologists, Western Section

(*Report by A. S. Crafts*)

The Western Section of the American Society of Plant Physiologists held its third annual meeting from June 21 to 24 at Balboa Park, San Diego. In what was declared by many to be the section's most successful meeting, a full program consisting of three sessions for submitted papers and four joint symposia was presented. Over fifty members registered and all meetings were well attended. Election of F. M. Eaton and J. R. Furr for chairman and vice-chairman, respectively, was announced at an informal dinner on Thursday evening.

The general session on Tuesday morning was devoted to papers on hormones, autonomic exudation cycle, bud inhibition, polarity and other topics involving autonomic responses in plants. This program served to show what rapid progress is being made in relating these complex activities of plants to the auxins and other growth factors.

The Thursday morning session for submitted papers covered topics of horticultural interest, including pest control and soil-plant relations. The Friday morning session provided papers of biochemical and nutritional interest. Of particular merit were reports on methods of study and results with microelements by D. I. Arnon and P. R. Stout. Folke Skoog presented evidence of a relation between zinc deficiency and auxin. These studies, conducted in Professor D. R. Hoagland's laboratory, mark a distinct advance in our knowledge of the function of metals in the nutrition of plants.

Symposia on "Salt Tolerance of Plants and Related Problems," "Plant Invasion on the Pacific Coast," "Cell-Wall Structure" and "Progress in Plant Science" presented cabable reviews in these various fields and emphasized the rapid advancement being made. Of outstanding interest were papers on salt absorption and translocation by D. R. Hoagland and T. C. Broyer, a discussion of the results of studying the plant remains found in adobe brick by G. W. Hendry and J. N. Bowman, papers on cell-wall structure by James Bonner and Wm. S. Stewart, of the California Institute of Technology, and reviews on "Plant Hormones," by F. W. Went, "Permeability," by L. R. Blinks, and "Nature of Viruses," by T. E. Rawlins. The extent to which x-ray analysis, polarized light and radioactive elements from the cyclotron are being used in biology indicates the progressive nature of research in this field of science.

Association of Pacific Coast Geographers

(*Report by Peveril Meigs, 3rd*)

Fourteen papers, two dinners and two field-excur-

sions marked the sessions of the Association of Pacific Coast Geographers. Thursday morning was devoted to an interesting series of papers on geographic problems of Southern California. Culture and erosion in the valleys and marine terraces were dealt with by R. M. Glendinning and George Carter. Reports on their geomorphologic studies in the San Gabriel Mountains were given by Gordon Oakeshott and Joseph Williams. Williams took challenging but convincing exception to some existing theories of physiographic history of the San Gabriels. Thursday afternoon was given over to a field-excursion led by Alvena Storm dealing with the historical evolution of San Diego. Some of the papers presented on Friday morning were: a survey of North American sand deserts, by Forrest Shreve; a study of the Rio Verde Valley, Arizona, by Agnes Allen; description of Papago villages, by J. W. Hoover; and survey of aboriginal trade routes for sea shells in the southwest, by Donald Brand. An analysis of middens has shown that shells for ornamental purposes had been brought into Arizona and New Mexico in large quantities from the Pacific Coast of Southern California, though the chief source of southwestern shells was the Gulf of California, and a few were brought from the Gulf of Mexico. On Friday afternoon a report by Russell McClure on the Hudson Bay wheat route was read, describing difficulties such as ice, fog and lack of return cargoes, but attaching considerable value to the route as a freight-rate-reducing competitor for Montreal. Peveril Meigs discussed the historical geography of water planning in the Great Central Valley of California, analyzing the changing plans of the past eighty years, culminating in the Central Valley Project now under construction.

At the annual dinner on Friday evening, John B. Leighly gave the presidential address, an analysis of methodologic controversies in nineteenth century German geography. The mystical attitude of Karl Ritter, occupant of the first academic chair ever established in geography, and the gradual breaking-away of geographers from the Ritterian philosophy, leading to the development of modern regional geography, formed the central themes of the address. Saturday was devoted to an all-day field excursion in the foggy coastal desert of Baja California, Mexico, led by Lauren Post and Peveril Meigs.

Officers elected: John B. Leighly, University of California, *president*; Frances M. Earle, University of Washington, *vice-president;* Peveril Meigs, 3rd, State College, Chico, California, *secretary-treasurer;* Otis W. Freeman, College of Education, Cheney, Washington, *editor of Yearbook.*

Astronomical Society of the Pacific

(*Report by Alfred H. Joy*)

On Wednesday afternoon, June 22, a joint session was held with the American Physical Society with an attendance of one hundred. A symposium on the subject, "Nuclear Transformations and their Astrophysical Significance," was held. The following topics were presented: "Nuclear Reactions as a Source of Energy," by W. A. Fowler, California Institute of Technology; "The Composition of Stellar Atmospheres," by R. Minkowski, Mount Wilson Observatory.

The details of the theory of possible nuclear changes in the lighter elements and the possibility of their application to the interior of stars were considered. On account of the limited observational data available it is difficult to compare proposed theoretical conditions with those prevailing in the stars themselves. Dr. Oppenheimer suggested a model with a high central concentration of neutrons.

Sessions for papers were held on Thursday, June 23, with an attendance of about fifty. An unusually wide range of topics was presented in twenty-nine papers from ten different institutions. They were well distributed in different fields and touched upon the asteroids, the sun, stars, variables, novae, nebulae, interstellar matter and instrumental equipment.

In the papers several points of especial interest were noted. D. M. Beard and Mrs. Kaster reported on determinations of the distance and orbit of the asteroid Hermes, which passed very near the earth in 1937. Mrs. Mulders's study of solar activity indicates that the maximum of the sun-spot curve was probably reached in July, 1937. E. Pettit showed photographs of a prominence which reached the record height of 960,000 miles. A. H. Joy gave the results of his study of galactic rotation based on the radial velocity of Cepheid variables, and H. W. Babcock presented a remarkable curve indicating the rotational velocities in the Andromeda nebula at different distances from the center. A direct determination of the darkening at the limb of an eclipsing star was observed by G. E. Kron with a new photoelectric photometer. The spectra of the two super-novae of 1937 were discussed by R. Minkowski, and F. Zwicky described his plan of search for such objects in the extra-galactic nebulae.

Professor R. T. Crawford, Professor W. T. Skilling and Dr. J. S. Plaskett presided at the various sessions in the absence of President Jeffers.

On Friday, June 24, a party of forty members of the society and their families visited Palomar Mountain and were shown the 200-inch dome and the 18-inch Schmidt telescope by Drs. Anderson and Zwicky and Captain McDowell.

Botanical Society of America, Pacific Section

(*Report by A. W. Haupt*)

The Botanical Society of America, Pacific Section, held two sessions at which papers were presented, one

symposium and two joint symposia with the Western Section of the American Society of Plant Physiologists. At the Tuesday morning session Geo. B. Rigg described a convenient light filter through which plants containing chlorophyll appear red while green paint appears green. H. S. Reed described structural changes in tomato leaves when the plants are grown in nutrient solutions lacking traces of copper or zinc salts. W. E. Allen pointed out that the structural features of certain marine plankton diatoms of the East Pacific are so variable that the identification of species is rendered difficult. Ivan C. Jagger and Thomas W. Whitaker reported on the occurrence of a hybrid between *Lactuca canadensis* and *L. graminifolia,* apparently the first record of an authentic species hybrid in the genus. A paper by Daniel I. Axelrod dealt with the fossil evidence regarding the age and origin of certain California endemics. By request, this paper was read again at the Tuesday afternoon symposium.

On Tuesday afternoon a symposium was held on the "History and Relationships of the Southwestern Flora," in which three invited speakers participated. R. W. Chaney, speaking on plant migrations of late geologic time in relation to modern plant distribution, emphasized that these migrations have been largely from the north, with local and temporary reversals at several times. As a result, many genera have become concentrated in the lower latitudes, others have been eliminated, and still others have survived in modified form. Philip A. Munz gave an illuminating account of endemism in Southern California, discussing the restricted distribution of species in each geographical area. An analysis of the flora of Arizona, showing the proportion of the different geographical elements, prepared by T. H. Kearney and R. H. Peebles, was presented by Mr. Peebles.

At the Thursday morning session, two papers were presented by G. J. Hollenberg, the first dealing with culture studies on the following marine algae from Southern California; *Eisenia arborea, Petrospongium rugosum* and *Hapterophycus canaliculatus.* The second paper was devoted to a description of *Amplisiphonia pacifica,* representing a new genus of Rhodomeliaceae.

At a short business session, held on Thursday morning, the following officers were elected for the coming year: *President,* LeRoy Abrams; *Secretary,* Ira L. Wiggins, Stanford University, California.

Ecological Society of America

(*Report by H. De Forest*)

The society held two sessions for the presentation of papers, on the morning and afternoon of Thursday, June 23. It organized two field trips, one for an examination of the trees and shrubs of Balboa Park, conducted by C. I. Jerabek, and one for the bird life, led by J. E. Crouch. It participated also in the Biologists' Dinner of Wednesday evening.

H. P. Hansen had a paper giving an analysis of bogs in the Puget Sound region, based on fossil-pollen studies, in which the post-glacial forest succession was presented. G. D. Pickford, in collaboration with E. H. Reid and L. A. Isaac, described the plant succession in a Douglas fir area of the Pacific Northwest which had undergone cutting, burning and grazing. E. Fritz reported on the accelerated growth of redwood in California after logging. M. W. Talbot, with H. H. Biswell and A. L. Hormay, described the abrupt and pronounced changes in the quantity and composition of the herbaceous annual vegetation in the grassland of the San Joaquin Valley of California. This extensive area contrasts sharply with other major forage regions of the West in its preponderance of annuals and its great abundance of species from the Old World. A. W. Sampson reported on the chemical composition of species as a factor in plant succession in several different plant communities of Central California. C. J. Kraebel and C. H. Gleason gave a paper on the sowing of mustard seed by hand and by airplane for erosion control in burned areas of chaparral in Southern California, reporting upon several ecological aspects of the problem after six years of governmental investigation. W. V. Turnage told of three different methods for determining soil temperature as employed in desert soils. A. G. Vestal discussed problems of the coastal sagebrush scrub and related plant communities—the garigue-like "bush" of Southern California. This was followed by an account of the federal government lysimeter installations in the chaparral scrub of Southern California, for evaluating the water relations of this vegetation, a paper by C. J. Kraebel and E. A. Coleman. Forrest Shreve offered a new classification of life-forms of the Sonoran Desert of North America and made use of a revised form of his map of this desert region. Twenty-five life-forms are recognized, a much larger number than is found in humid regions. Two papers, by C. E. ZoBell and W. E. Allen, and W. E. Allen, treated respectively of the marine phytoplankton near La Jolla, California, and of the offshore diatoms encountered on certain cruises of a research vessel. An increase of the phytoplankton of the sea was usually accompanied or followed by an increase in the bacterial population. The favorable influence of upwelling of ocean waters on diatom production was clearly shown. The greatest abundance of these forms was well away from shore.

Society for Experimental Biology and Medicine

(*Report by C. H. Thienes*)

The Pacific Coast and the Southern California

branches of the Society for Experimental Biology and Medicine met jointly on the afternoon of June 22. Eight papers were presented. Miles E. Drake, F. S. Modern, John F. Renshaw and C. H. Thienes described experiments by which they showed the post-ganglionic nature of sympathetic fibers and pre-ganglionic nature of the parasympathetic fibers in the mesentery of the intestine. Donald C. Collins discussed the use of papaverine in treating acute arterial embolism. The concentration of blood acetylcholinesterase is normal in diabetic patients and is uninfluenced by insulin or epinephrine, but its concentration is low in hepatic disease, according to A. E. Koehler and Y. J. Katz. Discussing tannic compounds in plants with "little-leaf," H. S. Reed showed lantern slides of the disorganization of plastids and deranged carbohydrate metabolism as a result of zinc deficiency in nutrient media for growing peach and apricot twigs. S. C. Rittenberg and C. E. ZoBell described the use of long "oval tubes" for growing anaerobic bacteria and showed that the oxidation-reduction potential of the media is more important than the quantity of free oxygen present for such organisms. Margaret Gulick Morehouse fed alpha, beta- and beta, gamma-deutero-butyric acid to rats during a period of endogenous ketosis. Twenty-five per cent. of the beta, gamma-compound appeared in the urine as deutero-beta-hydroxybutyric acid, while only 4 per cent. of the alpha, beta-compound was so excreted. A. Goetz and S. S. Goetz reduced yeast cells to $-185°$ and $-252°$ C., at varying rates. Evidence that vitrification resulted from rapid cooling and crystallization from slow cooling was presented. Such vitrification was reversible, with viable organisms recovered, while crystallization was lethal. Thermodynamic considerations were discussed. W. G. Clark observed marked decreases in the intestinal absorption of sodium chloride by adrenalectomized rats.

Society of American Bacteriologists, Southern California Branch

(Report by Meridian R. Greene)

Papers presented to members of the Southern California section of the Society of American Bacteriologists dealt with a sufficiently varied scope of material to satisfy the interests of those attending the session. Investigations by C. ZoBell, C. Feltham, T. D. Beckwith, E. Geary, C. Fish and R. Tracy pertaining to the metabolic activities of bacteria were reported. Encrustations on the bottoms of vessels increase their running expense; W. F. Whedon spoke on the rôle of marine microorganisms in the formation of a primary film on submerged surfaces. It is to such a film that invertebrates such as barnacles attach. The pathology of Aspergillus infection of penguins was described by L. F. Conti. These fowl were evidently infected in their native habitat, Peru. Fatalities occurred from this fungus a month after capture. Considerable discussion followed the paper of A. Hoyt on immunization of mice infected with the virus of rabies and that of Kessel and Stimpert on the antibody content of the serum of human cases of poliomyelitis, infected monkeys and normal people for neutralizing this virus.

Protection of the public from contaminated eating and drinking utensils is a current problem. Bacterial counts of wash and rinse water occur, not infrequently, in the millions. The best field procedure so far of value to the Los Angeles County Health Department was outlined by R. V. Stone. It includes three requirements: (1) A thermometer for checking the temperature of wash waters which should have a minimum of 120° F. (2) A sediment test for the physical demonstration that the water is dirty. (3) A chlorine test for checking the strength of chlorine rinses which should contain at least 100 p.p.m. A chlorine rinse is essential as hot water heaters usually fail to maintain efficiency during rush periods.

Western Society of Soil Science

(Report by J. C. Martin)

The Western Society of Soil Science held three half-day sessions at which were presented eighteen submitted papers in addition to a half-day joint session with the Western Section of the American Society of Plant Physiologists. The attendance ranged from forty to sixty persons.

In the opening half-day session the papers presented dealt with soil-profile development as studied in Utah by the Forest Service, soil-erosion studies by the Soil Conservation Service in cooperation with the University of Arizona and with the State College of Washington in which have been developed mathematical expressions of erodibility and in which it has been shown that the forces of perikinetic and orthokinetic coagulation operate in soil suspensions carried by streams. A mathematical expression for the removal of silt by irrigation water in relation to size of stream and slope of ground was proposed from the Utah Agricultural College. The importance of temperature variations on pressure potentials and rate of water uptake by soil columns with shallow water tables was discussed in the light of studies at the University of California.

During the second half-day the papers presented covered a wider range of soil investigations. Evidence pointing to the indispensability of iodine as a plant nutrient was offered from work done in Oregon; the effects of sorghum roots upon subsequent crop growth from the standpoint of their sugar content was discussed in the light of work done in California. In work reported from the University

of California, the absorption of potassium from suspensions of clay by excised barley roots was shown to be of some magnitude within a short time period and to be dependent on the degree of saturation of the clay with respect to that ion. The results of two years' work in the examination of leachings from "Russian type" lysimeters at Washington State College show that with annual precipitation of from 20 to 25 inches there has been appreciable leaching, some of which has been lateral in direction, and the magnitude of the nitrification processes has been indicated under different cropping systems. A new apparatus for the study of the effect of "puddling" soil on the binding of the soil moisture as developed at the University of Arizona was described and evidence presented to show that the "bound" water in soils is held, in part, in the form of a thixotropic gel. At the same institution certain correlations were shown between the rate of infiltration of water and the dispersion percentage of soil particles of 0.005 mm diameter.

During the last half-day's presentation of papers on measurement of oxidation-reduction potentials in alkaline calcareous soils as conducted at Arizona and also on the effects of soil-water ratios on the pH measurements in soils as studied at Arizona and the State College of Washington, much lively discussion developed. Microbial activities in the soil as studied at the State College of Washington point to the difference in the nature of the organic residue as being responsible for the development of divergent types of microflora in two important soils in that region. The examination of some typical range soils in Arizona showed the mountain meadows to be much richer in bacterial and actinomyces counts than the forested areas or the desert regions. The occurrence of algae in the soil and their important role in the economy of the soil as studied at Brigham Young University was presented as the closing paper; seasonal variation in the kinds of algae was shown to be evident as was decrease in numbers with depth of soil and with decrease in organic matter content of the soil.

The following officers were elected for the ensuing year: *President,* H. D. Chapman, University of California, Riverside; *Vice-President,* W. T. McGeorge, University of Arizona, Tucson; *Secretary-Treasurer,* J. C. Martin, University of California, Berkeley.

CONCURRENT MEETINGS OF ORGANIZATIONS NOT AFFILIATED WITH THE PACIFIC DIVISION, A.A.A.S.

AMERICAN ASSOCIATION OF PHYSICS TEACHERS

(Report by L. E. Dodd)

This young association, still in its first decade, is one of the newer affiliated societies of the American Association for the Advancement of Science. Appropriate therefore was its convening during the annual June meeting of the Pacific Division, A.A.A.S., its program thereby forming a part of the week's sessions of the larger association.

A luncheon on June 24 in charge of M. S. Allen, Long Beach Junior College, permitted the activities and plans of the American Association of Physics Teachers in the western United States to be discussed informally. Professor D. L. Webster, Stanford University, was called upon, and gave a stimulating impromptu talk. Participating in the discussion was A. A. Knowlton, Reed College, member of the national executive committee.

The afternoon program under the chairmanship of Professor Webster was divided into two parts. In the first group, the following five invited papers were presented: (a) "Equations of State for Physics Teachers," by W. P. Boynton, Oregon State College, Corvallis. He summarized an intensive study, giving a more generalized equation, with lantern slides of models of different thermodynamic surfaces. (b) "The Flying Laboratory," by A. A. Knowlton, which described his experimental study of the cause for an airplane's losing the guiding radio beam. This has been "a contributing factor in a considerable number of all major crashes of transport planes." (c) From the view-point of a high-school teacher, Roy W. McHenry, Escondido, California, discussed "The Physics Problem in High Schools." Four current problems are: lack of material equipment; the recent trend in shortening the time of classes; extremely wide range of abilities among the students, together with their lack of a reasonably adequate mathematical preparation; and the frequent limitations and handicaps of high-school physics teachers. These points aroused lively comments from the audience. (d) Relating the high school to the college, Paul S. Epstein, California Institute of Technology, presented "Mathematics in the Secondary School as Related to College Physics." Professor Epstein's analysis and suggestions were basic and enlightening. His paper, to be published in detail, will surely be read with interest and profit by many. (e) Ernest O. Lawrence, University of California, Berkeley, with outstanding achievements in current experimental research into the atom by means of his invention, the cyclotron, discussed "Relation of the Cyclotron to Present-day Courses in College Physics." Professor Lawrence gave a clear outline of how the present-day teacher should present to students the behavior of electrons in this effective type of modern apparatus.

The second group consisted of seven contributed papers, of which the first was by M. S. Allen, Long Beach Junior College, on "The Evaluation and Guidance of Functional Student Progress." The need for improving the student attitude toward physics was stressed, and suggestions were made as to how this might be done. He urged also helping the student to

maintain a balance, by not neglecting development of himself as a well-rounded individual, capable of meeting the larger social requirements. G. G. Kretschmar, Walla Walla College, offered practical suggestions, illustrated by slides, in "A Small Optics Shop as an Aid in Conducting an Intermediate Laboratory Course in Optics." J. L. Bohn and F. H. Nadig, Temple University (introduced by E. C. Watson), described "Hydrodynamic Apparatus for Demonstrations in Radioactivity," giving the necessary equations for the designs, illustrated with slides. Prepared papers read by title because of shortness of time in the one-half-day sessions were: "An Electrical Circuit Containing a Spark Gap," by W. P. Boynton; "An Approach for Introducing the Characteristics of Measurement," by L. E. Dodd; and "An Improved Method for Mapping Electric Fields," by H. C. Burbridge, Fresno State College.

A "Progress Report on the A.A.P.T. 'Manual of Demonstration Experiments,'" written by the editor-in-chief, R. M. Sutton, Haverford College, was read in his absence by a member of the editorial staff for the manual. This up-to-date and comprehensive manual for physics demonstration lecturers will describe about 1,200 experiments, in about 550 pages, with over 400 illustrations. More than 200 teachers contributed material. Having been three years in preparation, it is scheduled to appear in August, from the press of McGraw-Hill. Incidental to this progress report was an exhibit of specimen pages of the manual, selected from the printer's page-proof.

It is expected that most, if not all, of the papers will be published in early forthcoming issues of the association's journal, *The American Physics Teacher.*

The program committee comprised H. A. Kirkpatrick, Occidental College, R. H. Tileston, Pomona College, and L. E. Dodd (chairman), University of California at Los Angeles.

AMERICAN ANTHROPOLOGICAL ASSOCIATION, PACIFIC DIVISION

(Report by Malcolm J. Rogers)

The sessions of the American Anthropological Association, which extended over a period of three days, had a daily average attendance of fifty. Eighteen papers in all were read, nine of which dealt with integrating topics which were presented during the symposium on "The Problem of Culture Sequence on the West Coast." This theme was broadened somewhat by papers from adjacent fields. Ernst Antevs presented geological evidence bearing on the antiquity of the Cochise Complex of Arizona and E. B. Sayles the archeological aspects. A summary report on the culture sequence as known in the Nevadan field was presented by M. R. Harrington.

The most recent stratigraphic studies made in California, with a territorial range from Central California to Lower California, disclosed some major agreements and much localized pattern differentiation of a minor nature within the food-gathering horizon. The universal priority of the metate over the mortar was strongly indicated, but Ralph L. Beals, who summarized the symposium papers, was not in accord that the point was proved. In a reconstruction of the cultural prehistory of Southern California, Malcolm Rogers postulated two major horizons, a food-gathering one and an earlier hunting horizon. In connection with the latter horizon he offered evidence for a short chronology to replace the pluvial date which had hitherto been advanced for the appearance of man in California.

In the field of social anthropology, Edwin M. Loeb suggested psychological explanations for conditions obtaining in kin marriage and exogamy, and Peveril Meigs presented unique ethnological data regarding the Kiliwa Indians of Lower California.

VISION IN NATURE AND VISION AIDED BY SCIENCE; SCIENCE AND WARFARE.[1] II

By The Rt. Hon. LORD RAYLEIGH
PRESIDENT OF THE ASSOCIATION

The value to science as well as to daily life of the gelatine dry plate or film can hardly be overestimated. Take, for instance, the generalized principle of relativity, which attempts with considerable success to reduce the main feature of the cosmical process to a geometrical theory. The crucial test requires us to investigate the gravitational bending of light, by photographing the field of stars near the eclipsed sun. For this purpose the gelatine dry plate has been essential: and here, as we have seen, we get into complicated questions of bio-chemistry. This is to my mind a beautiful example of the interdependence of different branches of science and of the disadvantages of undue specialization (or should I say generalization?). We may attempt to reduce the cosmos to the dry bones of a geometrical theory, but in testing the theory we are compelled to have recourse again to the gelatine which we have discarded from the dry bones!

To come back, however, to the development of the

[1] Concluding part of the address of the President of the British Association for the Advancement of Science, Cambridge, August, 1938.

photographic retina, as I may call it. As is well known, the eye has maximum sensitivity to the yellow-green of the spectrum, but ordinary silver salts are not sensitive in this region. Their maximum is in the blue or violet, and ranges on through ultra-violet to the x-ray region. It was not at all easy to extend it on the other side through green, yellow and red to infra-red. The story of how this was ultimately attained is one more example in the chapter of accidental clues skilfully followed up which forms the history of this subject.

In 1873, Dr. Hermann Vogel, of Berlin, noticed that certain collodion plates of English manufacture, which he was using for spectrum photography, recorded the green of the spectrum to which the simple silver salts are practically insensitive. The plates had been coated with a mixture which contained nitrate of uranium, gum, gallic acid and a yellow coloring matter. What the purpose of this coating was is not very obvious. It rather reminds one of medieval medical prescriptions which made up in complexity what they lacked in clear thinking. But Vogel concluded with true scientific insight that it must owe the special property he had discovered to some constituent which absorbs the green of the spectrum more than the blue: for conservation of energy requires that the green should be absorbed if it is to act on the plate. He then tried staining the plate with coralline red, which has an absorption band in the green, with the expected result. With much prescience he says: "I think I am pretty well justified in inferring that we are in a position to render bromide of silver sensitive for any color we choose. Perhaps we may even arrive at this, namely photographing the ultra-red as we have already photographed the ultra-violet." It was, however, half a century before this far-seeing prophecy was fully realized. The development of the aniline color industry gave full scope for experiment, but it has been found by bitter experience that dyes which can produce the color sensitiveness are often fatal to the clean working and keeping qualities of the plate. However, success has been attained, largely by the efforts of Dr. W. H. Mills, of the chemical department of this university, and of Dr. Mees, of the Kodak Company; and we all see the fruits of it in the photographs by lamplight which are often reproduced in the newspapers.

It is now known in what direction the molecular structure of the sensitizing dye must be elaborated in order to push the action further and further into the infra-red, and the point when water becomes opaque has nearly been reached, with great extension of our knowledge of the solar spectrum. The spectra of the major planets have also been extended into the infra-red, and this has given the clue as to the true origin of the mysterious absorption bands due to their atmospheres, which had baffled spectroscopists for more than a generation. These bands have been shown by Wildt to be due to methane or marsh gas. Neptune, for example, has an atmosphere of methane equivalent to 25 miles thickness of the gas under standard conditions. In this Neptunian methane we have a paraffin certainly not of animal or vegetable origin; and I venture in passing to make the suggestion that geologists might usefully take it into consideration in discussing the origin of terrestrial petroleum.

The photographic plate is not the only useful substitute for the human retina. We have another in the photoelectric surface. The history of this discovery is of considerable interest. Heinrich Hertz, in his pioneering investigation of electric waves (1887), made use of the tiny spark which he obtained from his receiving circuit as an indicator. The younger part of my audience must remember that this was before the days of valves and loud speakers. His experiments were done within the walls of one room. When he boxed in the indicating spark so as to shield it from daylight and make it easier to see, he found that this precaution had exactly the opposite effect—the spark became less instead of more conspicuous. To express it shortly and colloquially, this action was found to depend on whether or not the spark of the receiver could see the spark of the oscillator. Moreover, seeing through a glass window would not do. It was ultra-violet light from the active spark that influenced the passive spark. Further, Hertz was able to determine that the action occurred mainly, if not entirely, at the cathode of the passive spark.

The next step was taken by Hallwachs, who showed that is was not necessary to work with the complicated conditions of the spark. He found that a clean zinc plate negatively charged rapidly lost its charge when illuminated by ultra-violet light.

The final important step was in the use of a clean surface of alkali metal *in vacuo* which responds to visible light and passes comparatively large currents. This constitutes the photoelectric cell very much as we now have it, and was due to two German schoolmasters, J. Elster and H. Geitel. English physicists who met them during their visit to Cambridge a generation ago will not fail to have agreeable memories of their single-minded enthusiasm and devoted mutual regard. Sir J. J. Thomson has recalled them to our recollection in his recent book. They could scarcely have foreseen that their work, carried out in a purely academic spirit, would make possible the talking films which give pleasure to untold millions.

The sensitiveness of the dark-adapted eye has often been referred to as one of its most wonderful features; but, under favorable conditions, the sensitivity of a photoelectric surface may even be superior. According to our present ideas, no device conceivable could do more than detect every quantum which fell upon it.

Neither the eye nor the photoelectric surface comes very near to this standard, but it would seem that the falling short is rather in detail than in principle. The action of the photoelectric cell depends on the liberation of an electron by one quantum of incident energy, and under favorable conditions the liberation of one electron can be detected, by an application of the principle of Geiger's counter. The action of the dark-adapted eye depends on the bleaching of the visual purple. According to the results of Dartnell, Goodeve and Lythgoe it appears likely that one quantum can bleach a molecule of this substance, and in all probability this results in the excitation of a nerve fiber, which carries its message to the brain.

The photoelectric cell can be used like the photographic plate at the focus of an astronomical telescope. It might seem from the standpoint of evolution a retrograde step to substitute a single sensitive element for the 137 million such elements in the human eye. In this connection it is interesting to note that in certain invertebrate animals eyes are known which have the character of a single sensitive element, with a lens to concentrate the light upon it. Such an eye can do little more than distinguish light from darkness. But its artificial counterpart using the photoelectric surface has the valuable property that the electric current which indicates that light is falling upon it can be precisely measured, so as to determine the intensity of the light. In contrast with photographic action, the energy available to produce the record comes not from the original source of light, which only, as it were, pulls the trigger, but from the battery in the local circuit, and it may be amplified so as to actuate robust mechanisms. It has been applied with success to guiding a large telescope or, in a humbler sphere, to open doors, or even to catch thieves.

However, the scientific interest lies more in the possibility of accurate measurement. As an interesting example we might take the problem of measuring the apparent diameter of the great nebula in Andromeda. As is known, modern research tends to indicate that the Andromeda nebula and other like systems are the counterparts of the galaxy, being in fact island universes. But until lately there was such a serious difficulty in that all such systems appeared to be considerably smaller than the galaxy. Stebbins and Whitford, by traversing a telescope armed with a photoelectric cell across the nebula, have found that its linear dimensions were twice as great as had been supposed, reducing the discrepancy of size to comparatively little.

But, it may be suggested, could we not go further and make a photoelectric equivalent, not only for the rudimentary kind of eye which has only a single sensitive element, but for the developed mammalian eye which has an enormous number? Could we not build up on separated photoeletric elements a complete and detailed picture? In point of fact this has been done in the development of television; and since this new art which interests us all can properly be considered as an extension of the powers of normal vision, no excuse is needed for devoting some consideration to it. We must divide the photoelectric surface into minute patches which are electrically insulated from one another. This is not too difficult; but if it were proposed directly to imitate nature, and attach a wire, representing a nerve fiber, to each of these patches, so as to connect it to the auxiliary apparatus, we might well despair of the task; for there are probably half a million such connections between the human retina and the brain. In the artificial apparatus for television, one single connection is made to serve, but it is in effect attached to each of the patches in rapid succession by the process of "scanning" the image. The photoelectric mosaic is on one side of a thin mica sheet, and a continuous metal coating on the other side gives the connection, which is by electrostatic induction. Each element of the surface forms a separate tiny condenser with the opposing part of the back plate. Scanning is achieved by rapidly traversing a beam of electrons over the mosaic line by line. The whole surface, and therefore each element, must be scanned at least twenty times a second. In the intervals an element is losing electrons more or less rapidly. The scanning beam comes along, and restores the lost electrons, discharges the little condenser found by the element and the back plate and sends an electric signal into the wire attached to this plate. The strength of this signal will depend on how many electrons the element had lost since the previous scanning, and thus on the luminous intensity of that part of the image. An important point is that the element is in action all the time, and not only while it is being scanned individually. We have thus transmuted the momentary picture into a series of electric pulses occupying in all a time of one twentieth of a second, and these can be amplified and sent out as wireless signals. How are they to be turned back again into a visible picture at the other end? Well, that is not perhaps so difficult as the first conversion of the picture into signals. We must make a beam of electrons follow and imitate the periodic movements of the scanning beam at the other end. The beam of electrons falls on a luminescent screen, and makes it light up, more or less brightly according to the intensity of the electron beam. If we use the incoming signals to modulate the electron beam, we can make them correspond with the intensities at the sending end, and the original picture is reconstructed piece by piece. The reconstruction is completed in one-twentieth of a second or less, and the process begins again. The successive pictures blend into one another as in the cinema, and movement is shown with apparent continuity.

It seems not unlikely that the electric eye or iconoscope, as it has been called, may have applications apart from television. Dr. V. K. Zworykin, who took an important part in its development, suggested that it might be used to make visible the image in the ultraviolet microscope, which would be much too faint for direct projection on a fluorescent screen. For that purpose the sending and receiving apparatus would, of course, be connected directly, without radio transmission. It might also be used for rapid photography, if the photographic plate replaced the viewing screen. The beauty of the device is that the energy is supplied locally, the distant light source merely releasing it. The principle of amplification may thus perhaps be applied to the photographing of faint objects.

I come to the close of this part of my subject.

Much of modern scientific doctrine appears at first sight to have an elusive and even metaphysical character, and this aspect of it seems to make the strongest appeal to many cultivated minds. Yet upon the whole, the main triumphs of science lie in the tangible facts which it has revealed; and it is these which will without doubt endure as a permanent memorial to our epoch. My main thesis has been that these are discovered by methods not essentially different from direct scrutiny. It is hoped that the present survey may remind you that if we allow for a reasonable broadening of the original meaning of the words, it remains true after all that "seeing is believing."

II. Science and Warfare

During the great war itself, few scientific men in any country doubted that it was their duty to do what they could to apply their specialized knowledge to the purposes of war; nor was it often suggested by publicists that there was any countervailing consideration: on the contrary they urged strongly that our resources in this direction should be efficiently mobilized. It is chiefly in vague general discussions that the opposite view becomes vocal.

Science, it is urged, is the source of all the trouble: and we may look to scientific men for some constructive contribution to finding a remedy. It is worth while to inquire what basis there is for this indictment, and whether, in fact, it is feasible for men of science to desist from labors which may have a disastrous outcome, or at any rate to help in guiding other men to use and not to abuse the fruits of those labors. I may say at the outset that I have no sanguine contribution to make. I believe that the whole idea that scientific men are specially responsible is a delusion born of imperfect knowledge of the real course of the process of discovery. Indeed, very much the same complaint was made before the scientific era. Let me refer you to Shakespeare's play of "Henry IV":

> Great pity, so it was
> This villainous saltpetre should be digged
> Out of the bowels of the harmless earth
> Which many a good tall fellow had destroyed
> So cowardly.

The quotation leads us to inquire how far the further development of this particular kind of frightfulness into modern high explosives was deliberate or not.

In the course of systematic study of the chemistry of carbon compounds it was inevitable that the action of nitric acid on substances like benzene, toluene, glycerine, cellulose and the like should be tried. No one could foresee the result. In the case of benzene, we have nitrobenzene, the key to the aniline dye industry. In the case of glycerine, Sobrero obtained in 1846 the highly explosive liquid called nitro-glycerine. He meant no harm, and in fact his discovery lay dormant for many years, until Nobel turned his attention to the matter in 1863, and showed how by mixing nitroglycerine with other substances, solid explosives could be made which admitted of safe handling. Dynamite was one of them. They proved invaluable in the arts of peace, *e.g.,* in mining and in making railway tunnels, such as those through the Alps. They were used by the Irish Fenians in the dynamite outrages of the eighties. These attempted outrages were not very successful, and so far as I know no one was inclined to blame science for them, any more than for the Gunpowder Plot. Like the latter, they came to be considered slightly comic. If any one doubts this, he may agreeably resolve his doubts by reading R. L. Stevenson's story "The Dynamiter." At all events, high explosives had been too long in use in peaceful industry for their misuse to be laid directly to the account of science.

Coming next to poison gas. We read that Pliny was overwhelmed and killed by sulfur dioxide in the eruption of Vesuvius in A.D. 79. During the Crimean War, the veteran admiral Lord Dundonald urged that the fumes of burning sulfur should be deliberately used in this way, but the suggestion was not adopted. Even if it had been, scientific research *ad hoc* would obviously have had little to do with the matter. During the great war, chlorine was used on a large scale. I need hardly insist that chlorine was not isolated by chemists for this purpose. It was discovered 140 years before, as a step in the inquiry into the nature of common salt.

Coming to the more recondite substances, we may take mustard gas—really a liquid—as typical. It is much more plausible to suggest that here was a scientific devilment, deliberately contrived to cripple and destroy. But what are the real facts?

Referring to Watts's "Dictionary of Chemistry" (edition of 1894), there is an article of less than forty words about mustard gas (under the heading of di-

chlordiethyl sulfide). After the method of preparation used by Victor Meyer has been mentioned, the substance is dismissed with the words "oil, very poisonous and violently inflames the skin. Difference from diethyl sulfide."

There are sixteen other compounds described at comparable length on the same page. So far as I know, none of them is of any importance. A not uncommon type of critic would probably say that the investigation of them had been useless, the work of unpractical dreamers, who might have been better employed. One of these substances, namely, mustard gas, is quite unexpectedly applied to war, and the production of it is held by the critics to be the work not of dreamers, but of fiends whose activities ought to be suppressed! Finally at the bottom of the page begins a long article on chloroform. This substance, as you know, has relieved a great deal of pain, and on the same principle the investigator who produced it was no doubt an angel of mercy. The trouble is that all the investigators proceeded in exactly the same spirit, the spirit, that is, of scientific curiosity, and with no possibility of telling whether the issue of their work would prove them to be fiends or dreamers or angels.

Again, there is the terror of thermite incendiary bombs, spreading fire broadcast through our great cities. The notion is sometimes encountered that thermite was invented for this purpose. Nothing could be further from the truth. I first made acquaintance with it myself in 1901 by hearing a lecture at the Royal Institution by the late Sir William Roberts Austen on "Metals as Fuel."[2] He drew attention to the great amount of energy which was liberated when aluminium combined with oxygen, and showed how aluminium powder mixed with red oxide of iron would react violently with it, withdrawing the oxygen from the iron, and becoming brilliantly incandescent in the process. He showed further how this mixture, called thermite, could be used for heating metal work locally, so as to make welds, *e.g.*, in joining two iron pipes end to end. I venture to say that it never occurred to him or to any of his hearers that thermite had any application in war.

In discussions of this kind a distinction is often implied between what I may call old-fashioned knowledge and modern scientific knowledge. The latter is considered to be the special handmaid of "frightfulness." The futility of this distinction is easily seen by considering a special case. Iron is thought of as belonging to the pre-scientific era, while aluminium is thought to belong to the scientific era. From the standpoint of chemistry both are metals, and the problem of producing them in either case is a chemical one. When produced they both have their function in "frightfulness": iron to cut and stab; aluminium to make thermite bombs to burn and destroy. If modern science makes its contribution to "frightfulness" in giving us aluminium, ancient craft did so in giving us iron. It is obviously absurd to make any distinction in principle between the two cases. Science properly understood includes all real knowledge about material things, whether that knowledge is old or new.

All these terrors have only become applicable against a civilian population by the development of aircraft. Military objects were certainly not the incentive of the successful pioneers of artificial flight. They were fascinated at first by the sport of gliding, and afterwards by a mechanical transport problem.

It is true that brilliant writers of imaginative fiction, such as Jules Verne and H. G. Wells, had foretold all, and more than all, the horrors that have since come to pass. But it is perhaps more to the point to inquire what were the contemporary views of practical men. The Wrights made their first successful flight in 1903. In 1904 I myself heard the then First Sea Lord of the Admiralty repudiate with scorn the suggestion that the Government were interesting themselves in the matter; and I know with equal definiteness that even as late as 1908 the Chief of the Imperial General Staff did not believe in the military importance of flight. Would it be fair then to blame the inventors for not having realized it, and for not having stayed their hands?

Summing up what may be learned from the experience of the past, I think we may say that the application of fundamental discoveries in science to purposes of war is altogether too remote for it to be possible to control such discoveries at the source.

For good or ill, the urge to explore the unknown is deep in the nature of some of us, and it will not be deterred by possible contingent results, which may not be, and generally are not, fully apparent till long after the death of the explorer. The world is ready to accept the gifts of science and to use them for its own purposes. It is difficult to see any sign that it is ready to accept the advice of scientific men as to what those uses should be.

Can we then do nothing? Frankly, I doubt whether we can do much, but there is one thing that may be attempted. The association has under consideration a division for study of the social relations of science which will attempt to bring the steady light of scientific truth to bear on vexed questions. We rejoice to know that our distinguished American visitors are in sympathy with this aim, and we hope that our discussions with them will bear useful if modest fruit in promoting international amity.

[2] *Proc. R. I.*, February 23, 1901, Vol. xvi, p. 496.

SCIENTIFIC EVENTS

THE BRITISH NON-MAGNETIC ROYAL RESEARCH SHIP

FURTHER particulars of the royal research ship, to be called *The Research,* which is now being built at Dartmouth by Philip and Son, Limited, to the designs of Sir Stanley Goodall, director of naval construction, have been released by the British Admiralty. According to a report in the London *Times,* this vessel is to carry on the international work of investigation performed by *The Carnegie,* of the Carnegie Institution of Washington, which was destroyed by fire at Samoa about nine years ago. The report calls attention to the generous help afforded by the Carnegie Institution in the loan of personnel and the specifications of *The Carnegie* and the instruments used in her.

Although authorized over three years ago, *The Research* is of such an unusual design that her construction has taken much longer than that of a normal ship. She is to cost about £188,500. The principal object in building her is to investigate the problems of the variation of the earth's magnetic field and atmospheric electricity. It is therefore essential that she should be virtually a non-magnetic ship, and the greatest care is being taken to eliminate, as far as possible, all ferrous material from the hull, machinery and stores.

Much research work was carried out by Messrs. Petters at their Yeovil works in order to reduce the quantity of steel in the Diesel engines. A bronze alloy is being used extensively, and the crankshaft is of special non-magnetic steel. Consideration is also being given to such matters as iron nails in packing cases, tin containers for food and cigarettes, cooking utensils, cutlery, razor blades, drums for paint and oil, and even the ship's typewriter, all of which must be non-magnetic.

The hull is being constructed of teak planks on brass frames, subdivided by eight watertight bulkheads. The keel, stem and stern posts are of teak and Canadian rock elm, copper sheathed. Anchors and cables and wire for the rigging will be of aluminum bronze. The ship will have a loaded displacement of 770 tons, and will be rigged as a brigantine, with a full sail area of about 12,000 square feet. The propelling machinery consists of a Petter atomic Diesel engine of 160 B.H.P., driving a two-bladed feathering propeller, and the auxiliary machinery for the dynamos, refrigerator, air compressor and winch includes one 18 h.p. and two 9 h.p. Diesel engines.

The speed will be 6½ knots, and with capacity for 14 tons of Diesel oil the ship will have an endurance of 3,000 miles. Over 20 special scientific instruments will be carried, for while the principal work will be in connection with terrestrial magnetism and atmospheric electricity, the ship will also undertake meteorological work and oceanographical work, for which purposes she will have both observatories and laboratories.

The Research will probably be launched next February and will be ready for her first cruise in October, 1939. The scientific men of the expedition will visit the Carnegie Institution at Washington and, after calling at South American ports, will examine an area in the South Atlantic between Tristan da Cunha and Capetown. When this work is completed *The Research* will make a circuit of the Indian Ocean, probably calling at Perth, Cocos Island, Colombo, Seychelles, Mauritius and Durban, where she should arrive about November, 1940. Her complement will include six officers, four scientific men and twenty-two petty officers and men.

THE FOURTEENTH INTERNATIONAL CONFERENCE ON DOCUMENTATION

THE International Federation for Documentation will hold its fourteenth International Conference on Documentation under the presidency of Sir William Bragg, president of the Royal Society, at Lady Margaret Hall, University of Oxford, from Wednesday morning, September 21, until Sunday, September 25. Afterwards on Monday, September 26, members of the conference will visit the Science Museum, London. Advantage will be taken of the meeting being in England to hold joint sessions on the mornings of Saturday and Sunday with the Association of Special Libraries and Information Bureaus. All those who appreciate the vital importance of the organization of knowledge will realize that the visit of this International Conference to England is an occasion of exceptional moment.

Papers will be read by leading authorities from all countries upon aspects of the following, and other, subjects: Theories of Classification, Cataloguing and Indexing; Methods and Apparatus used in the Organization of Libraries, Archive Repositories, Registering and Filing Centers; Photographic and other Copying Processes in the Application to Bibliographical Problems; The Making of Abstracts from Periodical Literature; possibilities of cooperation—Directories of Information; Exchanges between Publishing Bodies, National and International; The Loan of Books and Documents; principles and possibilities—The Practical Application and Use of Bibliographies. In particular an effort will be made to obtain adequate representation of the varying points of view of workers in diverse fields. At a recent international congress the view was expressed that it was desirable to widen the bases of international bibliography and documentation. At

the forthcoming conference a special attempt will be made to secure authoritative reports upon the present state of bibliographical work in such fields of learning as archeology, archive work, economics, history and linguistic studies, in addition to the natural sciences and their applications.

The program will include visits to some of the many interesting places in the neighborhood, together with other social functions. The total cost, exclusive of reports and visits, will not exceed £1 a day.

THE LEVERHULME FELLOWSHIPS

THE Advisory Committee for the Leverhulme Research Fellowships have recommended, and the trustees have approved, the following awards in scientific subjects tenable for varying periods up to two years:

W. Cule Davies, Ph.D., D.Sc., lecturer in chemistry, University College, Cardiff.—Studies of the organic compounds of nitrogen, phosphorus and arsenic.

Mrs. K. A. Esdaile, research worker, London.—A dictionary of English sculptors.

S. Goldstein, M.A., Ph.D., Stokes lecturer in mathematics, University of Cambridge.—The turbulent motion of fluids.

F. C. Happold, Ph.D., D.Sc., senior lecturer in biochemistry, University of Leeds.—The nutrition of the three types of *C. diphtheriae* in its relation to toxin production.

Miss M. W. Jepps, M.A., D.Sc., lecturer in zoology, University of Glasgow.—Studies in the structure and life cycles of certain marine protozoa.

A. King, M.Sc., D.I.C., assistant lecturer, Imperial College of Science and Technology, London.—Leader of expedition to carry out a biological, geological and physical examination of Jan Mayen Island in the Greenland Sea.

D. A. O'Duffy, B.Sc., research and development assistant, Bahrein Petroleum Company.—Lubrication problems at high pressures and temperatures.

O. A. Oeser, M.Sc., D.Phil., Ph.D., lecturer (head of department) in experimental psychology, St. Andrews University.—The "Combined" method in the social sciences.

G. B. B. M. Sutherland, M.A., Ph.D., fellow, lecturer and director of studies in natural sciences, Pembroke College, Cambridge.—The application of infra-red spectra to structural problems in chemistry and physics.

W. Taylor, D.Sc., lecturer in chemistry, the Polytechnic, London.—Substitution mechanisms in aliphatic compounds.

W. H. Thorpe, M.A., Ph.D., fellow and tutor, Jesus College, Cambridge.—The physiology of African Tropical Homoptera.

R. Wilson, M.A., senior lecturer in pure and applied mathematics, University College, Swansea.—The nature and position of the singularities of a function in relation to the coefficient theory of its Taylor series.

SIR RICHARD GREGORY'S LECTURE BEFORE THE CARNEGIE INSTITUTION OF WASHINGTON

THE Carnegie Institution of Washington announces that Sir Richard Gregory, distinguished English scientist, has accepted an invitation to deliver the next Elihu Root lecture at the institution's auditorium, Washington, D. C., on the evening of December 8.

The Elihu Root lecture series, of which this will be the fifth, was established by Carnegie Institution in honor of Mr. Root, who from the founding of the institution to his death in 1937 was a member of the board of trustees and its chairman during the last twenty-four years of his life.

Dedicated as these lectures are to a distinguished scholar widely known for his support of research, they focus attention on the influence of science upon human thought and in shaping attitudes towards life. The most eminent thinkers of the present day, particularly in fields of science, wherever situated, are invited, as opportunity presents, to take place on the roster of speakers.

Sir Richard Gregory has come into position of prominence and of great influence through the books he has written, the addresses he has delivered, and most of all through his brilliant editorship of *Nature*, an English journal which has become an international clearing house for preliminary announcement of scientific researches and results. For forty-five years he has served this journal, first, as assistant editor and, since 1919, as editor. During the period he has contributed to the journal literally thousands of columns of vigorous editorial comment and observation.

In recognition of his public and scientific services Sir Richard was knighted in 1919; in 1931 the hereditary rank of baronet was bestowed upon him. Among the many academic honors accorded him, he was elected a fellow of the Royal Society of London, in 1933, under a special statute reserved for those who "either have rendered conspicuous services to the cause of science, or are such that their election would be of benefit to the Society." Only ten other living fellows of the Royal Society, including Prime Ministers and peers of the realm, have been elected under this provision.

In the forthcoming institution lecture, Sir Richard will discuss "Cultural Contacts of Science." In this address he expects to deal chiefly with the influence that science exerts upon cultural values rather than with the services rendered to modern communities by the utilitarian uses to which scientific knowledge is put.

In the promotion of closer relationship between science and social problems and the progress and use of scientific knowledge in the service of the world of man, Sir Richard sees such contacts contributing not only to the development of social ethics but also to the evolving of spiritual convictions. He regrets that, in general, art and literature have not had their emotions aroused by the achievements of science which represent, he holds, the most wonderful works of man.

The message of science, he declares, is this: that not only the development of man's physical form but also of his ethical standards depends upon himself. He adds: "Man has the power to make the world a celestial dwelling place if he wishes or to reduce it to dust and ashes. He can promote the survival of any type he pleases—poet, philosopher, priest, or pugilist."

Carnegie Institution will publish Sir Richard's lecture in full so that all may obtain a copy who desire to do so.

FRANK F. BUNKER

RECENT DEATHS AND MEMORIALS

DR. OTTO HILGARD TITTMANN, connected with the U. S. Coast and Geodetic Survey since 1867, from 1900 to 1915 as superintendent, died on August 21 at the age of eighty-eight years.

DR. JOHN MARTIN WHEELER, professor of ophthalmology at Columbia University and director of the Eye Institute of the Columbia-Presbyterian Medical Center in New York City, died on August 22 at the age of fifty-eight years.

DR. GEORGE EDMUND DE SCHWEINITZ, professor emeritus of ophthalmology at the Graduate School of Medicine of the University of Pennsylvania, of which he was a trustee, died on August 22 at the age of seventy-nine years.

DARWIN M. ANDREWS, horticulturist of Boulder, Colorado, died on August 14 in his sixty-ninth year. Mr. Andrews was known for his work in the cultivation, selection and improvement of the native plant species of Colorado.

AT a meeting of the Osler Club of London on July 12 in honor of the eighty-ninth anniversary of the birth of Sir William Osler, Dr. Archibald Malloch delivered the eleventh Oslerian oration on "Osler." Among those who spoke were Dr. Harvey Cushing and Dr. Charles Singer.

A MEMORIAL to the late Professor Hideyo Noguchi and the late Dr. William Alexander Young was formally unveiled by Sir Arnold Hodson, K.C.M.G., on the second of April, 1938, at Accra, Gold Coast, Africa. A representative gathering of the people of Accra was present at the ceremony. Before the memorial was unveiled Dr. David Duff, director of medical services for the Gold Coast, gave a short account of the lives and work of Professor Noguchi and Dr. Young. In his address he stated that, in addition to the memorial, a brass plate, suitably inscribed, would shortly be placed in the room of the Medical Research Institute at Accra, where Noguchi and Young conducted their yellow fever studies.

SCIENTIFIC NOTES AND NEWS

SIR ARTHUR EDDINGTON was elected president of the International Astronomical Union at the sixth triennial meeting held at Stockholm from August 3 to 10. He succeeds Professor Ernest Esclangon, director of the Paris and Meudon Observatories. The next meeting of the union will be held in Switzerland in 1941.

THE election of honorary members of the Royal Society of Edinburgh included, in addition to Dr. Henry Norris Russell, announced in SCIENCE last week, Sir Thomas Lewis, physician-in-charge of the department of clinical research, University College Hospital, London, and Professor G. I. Taylor, Yarrow research professor of the Royal Society, fellow of Trinity College, Cambridge.

THE gold medal of the Royal Society of Medicine has been awarded to Dr. Wilfred Trotter, director of the Surgical Unit at University College Hospital, London. This was the seventh award of the medal, which is given triennially to a "scientist, man or woman, who has made valuable contributions to the science and art of medicine."

THE diploma of honor and medal of scientific merit of the Academy of Sciences and Arts of Rio de Janeiro has been conferred on Dr. B. N. Singh, Kapurthala professor of plant physiology and agricultural botany at the Benares Hindu University; on Dr. B. C. Guha, professor of applied chemistry at the University of Calcutta and honorary director of the department of biochemistry and nutrition of the Indian Institute for Medical Research, Calcutta, and on Dr. H. N. Mukherjee, of the department of biochemistry of Carmichael Medical College. Dr. Guha is known for his researches on vitamins and related subjects and Dr. Mukherjee for his work on insulin and allied themes.

DR. JAMES B. MURPHY, of the Rockefeller Institute for Medical Research, has received the degree of doctor of science from Oglethorpe University, Atlanta.

THE honorary doctorate of the University of Cologne has been conferred on Dr. W. L. Bragg, Cavendish professor of experimental physics at the University of Cambridge, formerly director of the National Physical Laboratory.

AT a convocation of the University of Oxford on August 11, the vice-chancellor presiding, the honorary degree of doctor of science was conferred on Dr. Charles Gustave Jung, professor of psychology in the University of Zurich. Dr. Jung presided over the

tenth International Medical Congress for Psychotherapy, which met in Oxford, this being the first time that the congress has met in an English-speaking country.

DR. HARRY A. CURTIS, chief chemical engineer of the Tennessee Valley Authority at Knoxville, has been appointed dean of engineering at the University of Missouri. He will succeed Dr. F. Ellis Johnson, who resigned this summer to become dean of engineering at the University of Wisconsin.

DR. WILLIAM I. MYERS, professor of farm finance, will return to Cornell University as head of the department of agricultural economics. Dr. Myers has had leave of absence extending to five years, during which he has been governor of the Farm Credit Administration at Washington.

DR. JULIUS LANE WILSON, of the Yale University Medical School, has been appointed associate professor of medicine in the School of Medicine of Tulane University.

DR. CHARLES A. SHULL, professor of plant physiology of the University of Chicago, will be guest professor of the department of botany and plant pathology of the Oklahoma Agricultural and Mechanical College during the autumn semester. He will give an advanced course in plant behavior, and will continue his editorial work on *Plant Physiology* and *The Botanical Gazette*. Dr. W. W. Ray, mycologist, has resigned an instructorship at Cornell University in order to accept an assistant professorship in the department of botany at the Oklahoma Agricultural and Mechanical College.

DR. ATHELSTON F. SPILHAUS, of the College of Engineering of New York University, has been made chairman of the newly established department of meteorology. It is planned to conduct research into factors influencing the weather and to train weather forecasters and observers for air lines, fisheries and other industries. Gardner Emmons, associate meteorologist of the central weather office of the U. S. Weather Bureau in Washington, has been appointed assistant professor. The meteorological observatory at University Heights will house the new department, and research work will be carried on at the Mount Whiteface Observatory, conducted jointly with the Rensselaer Polytechnic Institute on Whiteface Mountain, near Lake Placid.

DR. J. E. MYERS, senior lecturer in chemistry and secretary of the University of Manchester, since 1930 assistant to the vice-chancellor, has been appointed principal of the Manchester College of Technology.

Nature states that a new Institute for Atomic Physics has been inaugurated at the Royal Hungarian University for Technical and Economic Sciences, and Professor Z. Bay, formerly professor of theoretical physics in the University of Szeged, at present director of the Tungsram Research Laboratory of the United Incandescent Lamp and Electrical Company, has been appointed the first professor of atomic physics.

Industrial and Engineering Chemistry reports that Jan Wiertelak, docent in the chemistry of wood at the Polytechnic School in Warsaw, Poland, formerly research student at the U. S. Forest Products Laboratory at Madison, Wis., has been appointed associate professor and head of the Institute for Testing Materials at the Academy of Commerce in Poznań, Poland.

HORACE T. HERRICK has been appointed an assistant chief of the Bureau of Chemistry and Soils. Mr. Herrick will assume responsibility, on behalf of the Department of Agriculture, for the general direction and coordination of the chemical and chemical engineering investigations of the four regional research laboratories authorized in the Agricultural Adjustment Act of 1938 to conduct researches into and to develop new scientific, chemical and technical uses for farm products and by-products.

KIRIL SPIROFF has been promoted from assistant curator to curator of the A. E. Seaman Mineralogical Museum of the Michigan College of Mining and Technology.

DR. G. MACDONALD, medical officer in charge of the branch of the Ross Institute for Tropical Research in Ceylon, has been appointed assistant director of the institute and will assist Sir Malcolm Watson in London. Dr. Robert Svensson will take up the appointment in Ceylon. Dr. J. W. Foster, a newly appointed assistant director, will take charge of a new branch of the institute in the Gold Coast at the end of the year.

BY an order of the British Committee of Privy Council, made after consultation with the Medical Research Council and with the president of the Royal Society, Dr. C. R. Harington, professor of pathological chemistry, and Dr. W. W. C. Topley, professor of bacteriology and immunology, both of the University of London, have been appointed members of the Medical Research Council, in succession to Professor A. J. Clark and Sir John Ledingham, who retire in rotation on September 30.

DR. CARL LUCAS ALSBERG, director of the Giannini Foundation at the University of California, has become a member of the Division of Foreign Relations of the National Research Council.

DR. C. A. ADAMS, professor of engineering emeritus of Harvard University and consulting engineer of the Edward G. Budd Manufacturing Company, Phila-

delphia, and Dr. A. C. Fieldner, chief of the technologic branch of the U. S. Bureau of Mines, Washington, D. C., have been appointed members of the advisory committee of the thirteenth Exposition of Power and Mechanical Engineering to be held at Grand Central Palace, New York City, from December 5 to 10.

LIEUTENANT-COLONEL W. L. HARNETT, formerly professor of surgery at the Medical College of Calcutta and recently reader in surgery at the British Postgraduate Medical School, has been appointed medical secretary to the Clinical Cancer Research Committee of the British Empire Cancer Campaign.

LEWIS B. KELLUM, associate professor of geology, who has a year's leave of absence from the University of Michigan, is directing the exploration program of the Standard Vacuum Oil Company in New Zealand.

THE SMITHSONIAN INSTITUTION was represented on the recent Presidential cruise aboard the *U. S. S. Houston* by Dr. Waldo L. Schmitt, curator of marine invertebrates of the United States National Museum. Dr. Schmitt recently returned to the museum with considerable zoological, botanical and geological material. Of particular note is a large collection of fish, including a number of rare forms and several species new to the National Collections, secured by the President and members of his party, and series of specimens from seldom visited Clipperton Island.

DR. WILFRED H. OSGOOD, chief curator of zoology at the Field Museum of Natural History, returned to Chicago on August 18. Dr. Osgood left on May 15 as the head of an expedition conducted in south central New Mexico. He was accompanied by Dr. Frank W. Gorham, of Los Angeles, and Walter F. Nichols, of Pasadena. The expedition, personally financed by Dr. Osgood as a contributor to the museum, concentrated its efforts chiefly on the "white island" of sand in Tularosa basin, a desert region of some three hundred square miles, and in the adjoining territory where a black lava formation composes the ground surface. Approximately four hundred specimens of mammals, birds and reptiles, including a number of rare and odd species, were collected. In addition, Dr. Osgood obtained important zoological specimens in the Mogollon Mountains of New Mexico, in California and in Colorado.

ACCORDING to *Nature*, Professor C. D. Ellis, who holds the Wheatstone chair of physics at King's College, London, has been granted leave of absence for the Michaelmas and Lent terms in order to make a tour which has been arranged by the Conference of Canadian Universities. Professor Ellis plans to spend some time, up to a week or ten days, in most of the universities, in order to have ample opportunity for meeting the staff and for discussing matters of interest. He is leaving England in September, and will go first to Vancouver, and will visit Edmonton, Saskatoon, Winnipeg, Ottawa and Montreal before Christmas. Starting again in January, he will visit Hamilton, London, Toronto, Kingston, Quebec, Sackville, Halifax, returning to England at the end of March.

THE sixtieth meeting of the American Astronomical Society will be held at the University of Michigan from September 14 to 16, under the presidency of Dr. Robert G. Aitken, director emeritus of the Lick Observatory. The address of welcome will be given by Dr. Alexander G. Ruthven, president of the university. The annual dinner will be held on Friday evening at 7 o'clock at the Michigan Union. On Saturday morning there will be an inspection of the McMath-Hulbert Observatory and of the motion pictures of recent solar prominences, etc. After the close of the meeting an excursion is planned to Henry Ford's Greenfield village.

THE autumn meeting of the Electrochemical Society will be held at Rochester, New York, from October 12 to 15. The Hotel Seneca has been selected as headquarters. In addition to the program of technical papers there will be two special symposia. Dr. S. O. Morgan, of the Bell Telephone Laboratories, Summit, N. J., will preside over the symposium on "Plastics in the Electrochemical Industry," in which the speakers and their subjects are: Gordon M. Kline, U. S. Bureau of Standards, "Classification of Commercial Organic Plastics and Their Chemical Properties"; V. E. Meharg, Bakelite Corporation, "Thermosetting Plastics"; S. D. Douglas, Carbide and Carbon Chemicals Corporation, "Vinyl and Styrene Resins"; H. R. Dittmar, E. I. du Pont de Nemours, Inc., "Methacrylate Resins"; Shailer L. Bass, Dow Chemical Company, "Ethyl Cellulose and Styrene Plastics"; W. A. Yager, Bell Telephone Laboratories, "Dielectric Constant and Loss of Plastics as Related to Their Composition"; R. M. Fuoss, General Electric Company, "Electrical Properties of Polyvinyl Chloride Plastics"; Erik Ackerlind, Brooklyn, N. Y., "Dielectric Properties of Shellac." The second symposium will be devoted to "The Metallurgy of Silver." Dr. Lawrence Addicks, of Bel Air, Maryland, will be chairman of this session, to which Dr. F. C. Mathers will contribute two papers, one on silver alloys by deposition, another one on the porosity of silver plate; Dr. Colin G. Fink and V. S. de Marchi will speak on the silver-iron alloy. Dr. D. K. Alpern, of Brooklyn College, also is expected to take part.

EDWARD K. LOVE, a real estate dealer of St. Louis, has made a gift of $100,000 for the establishment of a Missouri Wildlife Conservation Foundation, the income to be used for purposes recommended by the State Conservation Commission.

DISCUSSION

THE QUESTION OF A SEASONAL STERILITY AMONG THE ESKIMOS

RECENTLY several references to a winter sterility among the Eskimos have appeared in the literature. This assumed fact has been used by some writers as a confirmation of their findings that the length of the day is influential in determining the breeding season of certain experimental animals. Apparently the support for this view-point rests, to a considerable degree at least, on the report made by Dr. Frederick A. Cook[1] in addressing the New York Obstetrical Society. His intimations that there is a sterility among the northern Greenland Eskimos during the winter months have not been satisfactorily substantiated. Since Dr. Cook has been quoted rather extensively it seems advisable to call attention to certain contradictory evidence based on more carefully collected data and made by observers of wider scientific experience with that Arctic race.

In support for his belief that there is a seasonal sterility among the Eskimos, Dr. Cook, ethnologist to the first Peary North Greenland Expedition, stated, "During the Arctic night the menstrual function is usually suppressed, not more than one woman in ten menstruating." He continued, "During the whole of this long Arctic night the secretions are diminished and the passions suppressed, resulting in great muscular debility. Our own party suffered in the same way." Further support for the existence of a seasonal sexual periodicity lies in his observation that, "The passions of these people are periodical, and their courtship is usually carried on after the return of the sun. . . . Naturally enough, then, the children are usually born at the beginning of the Arctic night, or about nine months from this time." In regard to the age of puberty Dr. Cook stated, "Although these girls attain their size early, they do not menstruate until the age of nineteen or twenty years."

The frequently quoted citation of Ploss[2] to the observation of MacDiarmid that the Eskimos do not menstruate until about the age of twenty-three and then only in the summer months would seem to lend some support to Cook's statements. However, it seems to be generally believed that neither the Eskimo's reckoning of his own age nor the white man's estimate of his age is reliable. Only the ages of those Eskimos whose births were recorded by some responsible agency, missionary or governmental, should be used where scientific accuracy is intended. Certainly no such data on the Polar Eskimos were available to MacDiarmid a century ago.

The above report of Dr. Cook was given considerable publicity a short time ago by Llewellyn,[3] who apparently accepts Cook's view-point without checking his evidence or his qualifications and speaks of the annual recurrence of a "menopause," likening it to a " 'species' of 'hibernation' " localized to the hypophysio-gonadal system. He believes this assumed phenomenon to be due to the lack of sunlight.

On the other hand, there is ample evidence to oppose the statement that the Eskimos generally are sterile in the winter. In his diary for October 17, 1908, Stefansson[4] mentions an Eskimo birth in Arctic North America, indicating a conception in January.

Peter Freuchen, not a casual visitor, but for eighteen years the Danish governor of the Thule colony in northern Greenland—the same region visited by MacDiarmid and Cook—made pertinent observations in a personal conversation with the author. He married a full-blooded Eskimo and raised a family. According to him, there is certainly no apparent decrease in the frequency of menstruation or sexual desire during the winter months. He believes that the chief cause of sexual debility, when present, is probably famine. True, his observations were made many years after those of Cook and still longer after the visit of MacDiarmid with Ross. The population was not quite so purely Eskimo, but there were many of the pure stock left and it is hard to believe that their reproductive biology would have changed in any important respect within a few generations.

Dr. A. Bertelsen,[5] chief of the medical service of Greenland, presents an analysis of the births between 1901 and 1930 in West Greenland. This study of 16,101 births, both legitimate and illegitimate, shows that more conceptions occurred in December and April than in any other months. Conceptions by months, figures adjusted to a basic average of 100 per month, are as follows: January 101, February 101, March 103, April 113, May 106, June 96, July 89, August 85, September 96, October 97, November 100, December 113. The high rate in April lends support to Ellsworth Huntington's "basic animal rhythm," though he does not quote Bertelsen in his recent book.[6] Bertelsen agrees that the high rate for April is due to the return of spring, and feels that the high figure for December is due to the social customs of visiting widely and otherwise celebrating the Christmas season. He finds no influence on conception dates exerted by customary wedding seasons. The low rates of conception in summer are correlated with the high death rates at that time, both of which are probably due to the poorer

[1] F. A. Cook, *Trans. N. Y. Obstet. Soc.* 1893–1894.
[2] E. M. Weyer, "The Eskimos," p. 48, 1932.
[3] Ll. J. Llewellyn, *Nature*, 129: 868, 1932.
[4] Vilhjalmur Stefansson, Am. Mus. Nat. Hist. Anthropological Papers, 14: 198, 1914.
[5] A. Bertelsen, *Meddelelser om Grønland*, Bd. 117: Nr. 1, 1935.
[6] Ellsworth Huntington, "Season of Birth," 1938.

health existent then. In a series of 127 women in North Greenland the average age of first menstruation was fifteen years and 5 months. In 42 full-blooded Eskimo women the average was fifteen years and 6 months.

Apparently Bertelsen had revised his belief in regard to the lack of a seasonal birth distribution, for Birket-Smith[7] quoted him as stating that north of Disko Bay in the Arctic regions proper the number of births increased greatly in the first three months of the year. The same phenomenon also occurred in the two most southerly districts. The statistics given later (Bertelsen, 1935) hardly support these statements.

Dr. Henry Greist, superintendent of the Point Barrow, Alaska, Presbyterian Hospital from 1921 to 1936, furnishes other pertinent information by private correspondence. He writes: "I cannot agree with those who regard the long winter night of the Arctic as inducing physiologically a tendency toward continence. Sexual desire is believed to be as actively manifest during the Arctic night, so called, as during the summer. If any difference at all there is *more* sexual congress during the winter than the summer. . . . Illicit intercourse is far greater in amount during the winter months than within the months of daylight." In regard to the onset of puberty, he agrees with Stefansson[8] that it is quite early in the Eskimo but differs with him as to the cause. Stefansson believes it to be due to the high temperatures maintained in the igloos, but Dr. Greist, in his professional calls, found a very large percentage of the population with no heat much of the time due to lack of fuel. He believes that the lack of privacy on the part of the parents, the crowded homes and the intimate relations on the part of the children lead to early sexual stimulation and that to early puberty. However, the cases of motherhood before fifteen years of age are very rare.

It seems inappropriate to attempt in this brief note any evaluation of the often contradictory evidence in regard to the age of puberty among the Eskimos, except to state the belief that some of the earlier estimates were likely too high. Furthermore, it seems unwise to consider the possibility of the existence of definitely limited seasons of reproduction in other human groups, in regard to which it seems very probable that much of the published material available is based on inadequate data. This paper is merely an attempt to show that there is good reason to believe that Dr. Cook's original observations do not apply to any considerable group of Eskimos and should not be so construed. Regardless of what effect the length of day may have on the reproductive functions of certain experimental animals the Eskimos do not experience a sexual sterility during the long winter night.

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[7] Birket-Smith, "Greenland," Vol. II, p. 24, 1928.
[8] Vilhjalmur Stefansson, *Jour. Am. Med. Asn.*, 75: 669–670, 1920.

INSECT ZOO AS A WILDLIFE CONSERVATION PROJECT

IN September, 1934, there was opened at Goddard Memorial Park, for one experimental month, the Rhode Island Insect Zoo. Its founder and director was Brayton Eddy, national lecturer on entomological subjects. Believing that man will not kill what he appreciates and does not fear, Mr. Eddy undertook to build up an appreciation of insect life by presenting some 150 species alive within environmental display cases which he himself designed. Accompanying the exhibits were descriptive cards giving highlights upon the different species exhibited.

The policy of the insect zoo was to display native insects and animals which feed upon insects, to the end that the general public might be brought to a fuller understanding of the forces operating to promote biological balance. The nature of each animal was defined—whether it was a parasite, predator, scavenger or plant-eater—and the direct effect it might have upon the human race was indicated. In that one experimental month the number of visitors exceeded 30,000 people.

During the summers of 1935 and 1936 the Rhode Island Insect Zoo was considerably enlarged until this summer—when it has been moved to Nooseneck Hill, Rhode Island, under the name Rhode Island Insect Zoo and Nature Center. As a nature center, the exhibit has been augmented by introducing insect-eaters from other states, seasonal wild flowers and local minerals. It has been used to promote pride and appreciation of wildlife and minerals in the hearts of both local visitors and tourists.

The need of something more than government bulletins, photographs, drawings and mounted specimens in getting scientific truths before the general public has long been felt. Insect bulletins tend to pile up on the shelf, gathering dust, while crops are consumed by the very insects they were written to control. How to get the information out of bulletins and offered to the general public in such form that it could be easily grasped was the task to which Mr. Eddy set himself.

He believed that the problem was one of education, but education of a particular kind—education by demonstration. First get the public, then tell your story. The value of live animals in drawing a crowd has long been recognized. Instead of using the crowd as possible purchasers of commercial products, use it as consumers of information on wildlife conservation and insect control problems. Demonstrate the value of

calosoma beetles, praying mantes, skunks, crows, snakes and other misunderstood creatures by feeding them in public during certain announced hours of the day.

This is what has been done at the Rhode Island Insect Zoo, and the result has been amazing. People never before interested in small wildlife, or interested only superficially, have come to the insect zoo and spent hours in its perusal. By displaying live examples of the only four types of poisonous snakes in North America, respect and appreciation of all other snakes has been encouraged. By displaying the one species of poisonous lizard in the United States, the same is done for lizards. Local insects lose their horror when the few pain-givers—those which sting and those which cause a rash when handled—are represented by live specimens. Exhibiting the black widow spider and the tarantula, and explaining that they alone—of all spiders in Rhode Island—are dangerously poisonous, the lives of many other harmless and beneficial spiders are being spared.

To-day the insect zoo and nature center has become first port of call for many farmers and gardeners who are suffering from insect and other pests. Specimens are brought in for identification and for comparison with other specimens in the exhibit cases. Questions on insect control are incessant. The statement is repeatedly heard made by the departing visitor, "Well, I won't be killing them any more."

In the eight summer months which the zoo has been in operation, over 600 species of live insects and insect-eaters have been on display. Many more have been identified and added to the type collection of Rhode Island insects which is being kept for scientific reference. Over 105,000 visitors have attended. The zoo is situated twenty-three miles south of Providence, R. I., Route No. 3. It is open daily from 10:00 A.M. to 10:00 P.M. until October 2. The state cooperates in the matter of site and advertising, but leaves it to the fifteen-cent entrance fee to pay running expenses. Its purpose is educational. Members of the American Association for the Advancement of Science are always welcome, particularly if their attitude is critical.

BRAYTON EDDY

REGULAR POLYHEDROIDS

THE readers of SCIENCE may be interested to know that the results in the article by E. R. Bartlam entitled "On the Properties of Rectilinear Figures of n Dimensions" (SCIENCE, July 1) are special cases of those found by Stringham[1] in his exhaustive study. Stringham extended Euler's polyhedral theorem to n-dimensional space and showed that regular self dual $(n+1)$-hedroids analogous to the tetrahedron exist in any n-dimensional Euclidean space and that the number of regular elements of different dimensions, triangles, tetrahedra, etc., which bound these polyhedroids, are given by the expansion of $(1-1)^{n+1}$, excluding the first and last terms.

He showed that dual (2^n)-hedroids and $(2n)$-hedroids analogous to the dual polyhedra, the octahedron and cube, also exist in any n-dimensional Euclidean space and that the number of regular elements of different dimensions, triangles, tetrahedra, etc., or squares, cubes, tesseracts, etc., which bound these polyhedroids are given by the expansion, in direct and reverse order, respectively, of $(2-1)^n$ excluding the last term. Bartlam's table gives special cases of this theorem.

Stringham showed that no other real regular polyhedroids can exist in n-dimensional spaces when $n>4$. In three-dimensional space there are of course in addition the two dual polyhedra, the dodecahedron and the icosahedron.

Stringham finally showed that in four-dimensional space there exist also a self dual (24)-hedroid whose boundaries are regular octahedra, and two dual polyhedroids, a (120)-hedroid with dodecahedral boundaries and a (600)-hedroid with tetrahedral boundaries.

L. B. TUCKERMAN

NATIONAL BUREAU OF STANDARDS

QUOTATIONS

SCIENCE IN PRACTICE AND THEORY

ONE of the prime functions of the annual meetings of the British Association is to serve as a reminder to the nation at large of the basic importance and interest of natural science, alike in its philosophical bearings, its practical results, and its social implications; and the president, in his address, has an unrivalled opportunity of crystallizing this aspect of the association's work. This year's president, Lord Rayleigh, distinguished scientific son of a distinguished scientific father, has taken full advantage of this opportunity. He has discussed not only certain recent advances in pure knowledge and numerous remarkable practical applications of such knowledge, but also some of the ethical problems as well as the philosophical puzzles arising from recent scientific advance. The ethical problem concerns the relation of science in general and the individual scientist in particular to war and

[1] W. I. Stringham, *Am. Jour. Mathematics*, 3: 1, 1–14, March, 1880.

the preparations for war. The present time is exceptional in the wide divergence of opinion on the subject. In earlier periods men of science found themselves in no dilemma. In general, either they were not asked to put their knowledge to military use, or, if asked, they did so unquestioningly. The increasing importance of applied science in warfare is now, we see, assisting the virtual conscription of scientific knowledge for military purposes; and the resultant increase in the horrors of war, together with the growing realization of war's futility and wastefulness, has caused new heart-searchings among scientific workers.

Lord Rayleigh confines himself in the main to pointing out that science can not be blamed for the horrors of war. Those inventions which have made modern warfare more horrible, including mustard gas and incendiary bombs, are almost without exception applications of old scientific discoveries, made with no military objective. As he rightly concludes, science is the outcome of the urge to explore the unknown, and its results can not be divided into sheep and goats. Science is of its nature ethically neutral; what good or evil use is made of its discoveries depends on society at large. The problem remains, however, as to the conduct of individual men of science in putting their knowledge at the service of the war machine. Opinions are bound to differ on this subject. The view accepted by most scientists seems to be that this is a matter of individual conscience just as much as readiness to serve in any other direct or indirect military capacity. It is true that the man of science has greater potentialities for good or evil as a technical adviser than as a private or even as a colonel: but this does not alter the nature of the problem.

There is finally the question whether we can do anything in the matter. Lord Rayleigh is frankly sceptical, but allows a modest ray of hope in the proposal to establish a division of the association for the study of the social relations of science. So far as there are likely to be immediate results, scepticism is undoubtedly justified. But in the long run perhaps a more hopeful view may be taken. The scientific study of human nature, especially in its social aspect, is only in its infancy. As Dr. Glover forcibly pointed out a few years back, the causes of war are at least as much psychological as economic. Repression and frustration in early life engender unconscious cruelty whose natural outlet is violence, and mass suggestibility, under the influence of propaganda, generates an irresistible mass hysteria, a neurosis of society. Theoretically, at least, it is possible to plan a system of education which would allow the natural impulses to be expressed instead of repressed, thus removing the dangerous because unconscious mainspring of violence, and making it possible to harness the deep psychological forces to construction instead of destruction; and one which, instead of fostering suggestibility and material respect for authority as such, would encourage critical reflection and a healthy distrust of propaganda. A society educated thus would be a new kind of society, of its very nature much less inclined to make war than ours. Admittedly this is remote; but is it more remote than was our electric age from the age of Galvani or of Ampère, or even of Faraday? To apply scientific method to the study and control of human nature, new techniques and a new approach are necessary; but there is no reason to suppose that it can not be done, and many reasons for supposing that in doing so lies the world's chief hope of emerging from chaos and frustration.—*The Times, London.*

SCIENTIFIC BOOKS

QUANTUM MECHANICS

The Fundamental Principles of Quantum Mechanics. With Elementary Applications. By EDWIN C. KEMBLE. McGraw-Hill, New York and London, 1937. xviii + 611 pp. $6.00.

THE classical or Hamiltonian dynamics arose from celestial mechanics, especially the study of the motion of the solar system under gravitation. It provided a consistent mathematical system of equations representing these motions very accurately. Exact solutions of these equations can only be obtained in simple cases; and it is still doubtful over how long a period of time the approximate solutions can be applied. There are still unsolved mathematical difficulties involved in the long time solution of the problem of three bodies. Classical electrodynamics arose from physical experiment. It provided a consistent system of equations representing the action of electric and magnetic forces on matter in bulk regarded as generally continuous. It was applied to give a consistent theory of radiation moving with the velocity of light in empty space. Classical statistical mechanics applied classical dynamics to the motion of chemical molecules. There were three principal but not exclusive methods of attempting to surmount the mathematical difficulties; that associated especially with Maxwell, assuming "continuity of path"; that especially due to Boltzmann, using collisions and the H-theorem; and that of Gibbs, using from the beginning an "ensemble" of states taken by the assemblies of molecules with various probabilities. These methods arrived at essentially the

same result; that isolated closed systems and systems contained in thermostats would approach a statistical equilibrium in which the general laws of thermodynamics would hold; but they gave, for instance, specific heats disagreeing with observation. "Continuity of path" has only recently been justified by the work of T. M. Cherry, Birkhoff and J. v. Neumann.

With the discovery of the electron came the attempt to apply electrodynamics to the motion of single electrons and statistical mechanics to the motion of assemblies of electrons; leading to the well-known interconnected disagreements with observation in the thermodynamics of radiation and in the processes of emission and absorption of radiation. The attempt to describe the electron itself in terms of its field alone also led to an impasse. Some of these difficulties were met by the introduction of the quantum theory by Planck and Bohr, first in *ad hoc* assumptions about the processes of emission and absorption of radiation and the possible intermediate states of atoms. The methods of statistical mechanics were extended especially by Planck and by Darwin and Fowler. Various theoretical results were verified by observation and new difficulties arose. These led to a new discussion of the nature of our knowledge of atoms by Bohr and Heisenberg and to the introduction by Heisenberg and Dirac of matrix and operator mechanics; and to that of wave mechanics by De Broglie and Schrödinger. It was said even before matrix or wave mechanics were developed that, while the theory of relativity on the one hand dealt with physical problems in which the quantum of action could be regarded as negligibly small, but the time taken by light to pass from one part of the system to another was taken into account, the quantum theory on the other hand dealt with physical problems in which the latter could be neglected, but not the former.

Now the development of quantum mechanics has led to a formulation which seems to be logically complete when the time of passage of light can be neglected. It provides a consistent set of mathematical equations to represent the observable properties of atomic systems. There are no outstanding discrepancies between conclusions drawn from this theory within its range of validity, and observation; while many new phenomena, such as electron diffraction, have been given no other explanation. The observable properties of atoms are generally to some extent of a statistical nature, and the connection between the solutions of the equations and observation requires careful discussion; while the quantum statistical mechanics for assemblies of atoms requires the special foundation provided by J. v. Neumann. Just as in classical dynamics, when three or more bodies are involved, the equations are not exactly soluble, and there still remain mathematical difficulties in their treatment. Indeed, very little certain is known about the solution of the mathematical problem that must be solved to deal with the continuous spectrum in the many body problem. Moreover, in statistical mechanics difficulties like those of classical statistical mechanics remain. Quantum mechanics has been extended to take account of the finite time of propagation of light only in a somewhat tentative way and "quantum electrodynamics," if it is on the right track at all, is far even from providing a consistent set of mathematical equations; while no description of an electron in terms of its field alone has yet proved satisfactory.

Professor Kemble's "Fundamental Principles of Quantum Mechanics" is, in my opinion, an important work likely to be useful both as a reference book for mathematical methods to the research worker and as a text-book for the graduate student of theoretical physics. It covers generally the ground of non-relativistic quantum-mechanics, which, as stated above, now forms as logically complete and consistent a system as classical dynamics. The manner in which these mathematical equations describe the observable properties of atomic systems are explained, and the most part of the mathematical methods that have been employed to solve the equations are discussed in detail; the foundations are laid for the quantum treatment of statistical mechanics and of the structure of many electron atoms. I think this book is especially good in its clear explanation of the mathematics used in quantum theory and in its accurate statement of the limitations of that mathematics.

In the first two chapters wave mechanics in the Schrödinger form is built up from classical mechanics and selected observational results using the analogy of the relation of physical to geometrical optics, and the statistical interpretation of wave mechanics is explained, finishing up with the uncertainty principle. In the next four chapters a large number of mathematical methods for exact and approximate solution of the wave equation are considered. One-dimensional problems, separable problems in several dimensions, the continuous spectrum, and finally "The Existence and Properties of Solutions of the Many-particle Schrödinger Eigenvalue-Eigenfunction Problem" are dealt with in succession. This part of the book is especially excellent in pointing out how far the mathematics really goes and what is uncertain and unproved; it contains much material that is not to be found collected together, if at all, elsewhere; and forms the exact mathematical background of the theory.

The next three chapters introduce the general theory of operators representing dynamical variables; their properties; and the theory of their measurement. To

this part a quotation from the preface applies most directly. "A feature of the present volume on the physical and philosophical side is its consistent emphasis on the operational point of view and on the fundamental importance of Gibbsian assemblages of independent systems in the physical interpretation of the mathematical formalism." While the reviewer is in complete agreement with the second part of this statement, he does not agree so well with the first part. While it is valuable to know how far operational treatment is possible, one must start somewhere; and in many connections an alternative emphasis, stressing, with Norman Campbell, the theory-fact scheme of treatment of measurement, and allowing such ideas at least as probabilities of unmeasured positions in the theory, seems to be much more convenient, especially as, as Professor Kemble admits, in dealing with probability the operational theory presents difficulties, while an hypothesis-fact picture, such as that of Harold Jeffreys or such as the reviewer believes could be made with the aid of the "likelihoods" of R. A. Fisher, seems much simpler. But these are very much matters of opinion, and the difference may be mainly about words.

The next two chapters, ten and eleven, deal with matrix theory and perturbations not involving the time, including a discussion of the variational method. The following chapter is entitled "Quantum Statistical-Mechanics and the Einstein Transition Probabilities." The first part endeavors, in very small compass, to lay the foundations of statistical mechanics, using the methods of J. v. Neumann and directing the arguments towards a proof that, roughly speaking, as in classical mechanics, an assembly of molecules will tend to a state of statistical equilibrium—in classical mechanics such a proof makes use of the H-theorem or of continuity of path; so in quantum theory, a pure state of such an assembly will after some time be indistinguishable from a Gibbsian mixture. The reviewer finds this argument very difficult reading and has not satisfied himself that the steps all follow, though he feels sure that an argument can be carried through on these lines. He hopes that in some future edition this part of the book may be considerably expanded. He thinks that a discussion of the extension of Gibbs's own arguments, making use of maximum and minimum properties of canonical ensembles, to quantum theory, such as given by Delbrück and Molière, would find a place at this point; though perhaps that would be going further into statistical mechanics than the author intends. This statistical theory is then used to give a mathematically well-grounded first approximation treatment of absorption and stimulated emission of radiation.

The last two chapters contain discussions of electron spin and approximate relativistic theory and a rather detailed discussion of the problem of atomic structure, in which the assumptions and approximations made are carefully stated. The book concludes with appendices on particular mathematical points and name and subject indexes. It is well printed and this reviewer has discovered very few misprints. That, p. xviii, Condon and Shortley's "The Theory of Atomic Spectra" is attributed to "Oxford" instead of "Cambridge" may perhaps be noted.

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SPECIAL ARTICLES

ROD-CONE DARK ADAPTATION AND VITAMIN A

THE association of vitamin A with the visual cycle has by now been firmly established not only indirectly by the occurrence of nightblindness with vitamin A lack,[1] but by the direct chemical identification in the retina of vitamin A and the carotenoid retinene.[2] Because of the presence of nightblindness and of the relation of retinene to visual purple, this association has generally been attributed to the retinal rods, since they mediate vision at low illuminations and contain visual purple.

However, the behavior of the rods and cones is so alike in many visual functions[3] that the association of vitamin A with cone vision also seemed quite probable. This has now been demonstrated by Haig, Hecht and Patek's recent study[4] of the dark adaptation of persons with cirrhosis of the liver. Such individuals are less sensitive to light than normal people, and the loss of sensibility occurs both in cone vision and in rod vision. With substantial additions of vitamin A to the diet, the subjects improve in visual function and become normal. The essential point is that the two retinal systems behave in a parallel manner during the various stages of vitamin A therapy, indicating that vitamin A is just as essential for the restoration of cone visual function as for rod visual function.

In cirrhosis, the flow of vitamin A from food to eye is disturbed by the failure of liver function. One starts with an abnormal visual condition, and by the

[1] L. S. Fridericia and E. Holm, *Am. Jour. Physiol.*, 73: 63, 1925; K. Tansley, *Jour. Physiol.*, 71: 442, 1931.
[2] G. Wald, *Jour. Gen. Physiol.*, 18: 905, 1935, and 19: 351, 1935.
[3] S. Hecht, *Physiol. Rev.*, 17: 239, 1937; "La Base Chimique et Structurale de la Vision," Hermann and Co., Paris, 1938, 97 pp.
[4] C. Haig, S. Hecht and A. J. Patek, SCIENCE, 87: 534–536, 1938.

addition of vitamin A eventually reaches a normal state, which can be maintained only by large dietary supplements of vitamin.

Because of this pathological factor, it seemed desirable to test the conclusions of Haig, Hecht and Patek by a study of normal individuals. We therefore measured the dark adaptation of four normal young men, first on their regular and adequate diet, and then on a diet containing only about 150 units of vitamin A per day in order to see whether under these circumstances rod and cone behavior also run parallel courses. Jeghers[5] has already made measurements of dark adaptation on one person subjected to vitamin A deficient diet, but due to inadequate apparatus and procedure his data do not separate rod and cone adaptation and thus fail to answer the present question.

Our measurements were made under carefully specified conditions so as clearly to separate rod and cone adaptation. We used the new adaptometer described by Hecht and Shlaer[6] and adopted their standard procedure involving preadaptation to 1,500 millilamberts for 3 minutes, and measurements with extreme violet light of the adaptation of a retinal area 3° in diameter situated 7° nasally from the fovea.

The results show unequivocally that cone function is affected by vitamin A changes, just as rod function is affected by them. Fig. 1 gives five curves of dark

FIG. 1. Dark adaptation curves made at various times during a vitamin-A-free diet. Each point is a single observation.

adaptation made with one subject during different stages of the deficient diet. In all the curves, the first section, occurring fairly rapidly, represents cone adaptation; after this reaches a level in a few minutes, the second section representing rod adaptation begins fairly abruptly after about 7 minutes in the dark. This cone-rod transition point remains the same during all the vicissitudes of the diet, and this is true for all four subjects. Such was not the case with the cirrhosis subjects, who showed an initial displacement of the transition point to as long as 15 minutes and its gradual migration toward the normal time during the course of therapy.

Fig. 1 shows that as the stores of vitamin A in the body become exhausted, the general intensity level for both rods and cones rises. This is true not only for the final thresholds of cones and rods, but of the curves as a whole. The parallelism in behavior of the two functions is best shown in Fig. 2, where the data for

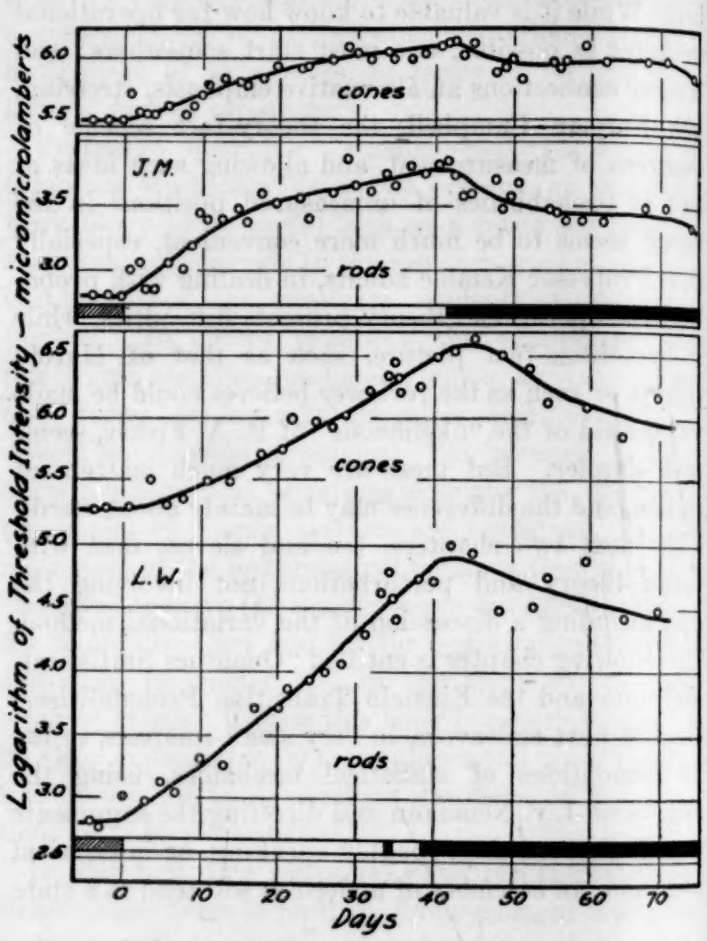

FIG. 2. The final rod and cone thresholds of two subjects on a vitamin A controlled diet. The diagonally shaded part represents a normal diet; the clear part is a practically vitamin-free diet; and the black part represents a normal diet plus 50,000 units of vitamin A daily. Note the points above the narrow black area for L. W. Both for rods and cones, this single administration of a large dose of vitamin A (100,000 units) seemed to cause a drop in threshold during the same day. In view of the prolonged time subsequently required for the threshold to come down to normal on a supplemented diet, we have not taken these points too seriously.

two subjects are drawn. Those for J. M. are about average, while L. W. represents the extreme effect of the four subjects. Each point is the final threshold secured either from the cone or the rod sections of such curves as in Fig. 1. All subjects had been studied for several weeks before beginning the diet, and the thresholds from the last two runs made on the normal diet are shown above the diagonally shaded area in Fig. 2. The clear area represents the duration of the deficient

[5] H. Jeghers, *Jour. Am. Med. Asn.*, 109: 756, 1938.
[6] S. Hecht and S. Shlaer, *Jour. Opt. Soc. Am.*, 28: 1938.

diet. The similarity in behavior of cones and rods in dark adaptation is obvious.

The black area means the return to a normal diet supplemented by 50,000 units of vitamin A per day. L. W. received 100,000 units in one day, but became ill for a few days following, during which he ate almost nothing and only resumed a supplemented normal diet later as indicated. The other two subjects merely returned to a normal diet without supplementary vitamin A. As Fig. 2 shows, there has been no spectacular return of visual function to normal on the resumption of regular and even excessive vitamin A consumption such as has been reported previously.[5, 7] There is a slightly rapid drop in threshold at first, but this gives way to a gradual decrease in threshold, and it may take longer to achieve complete recovery of function than it took to lose it.

For an understanding of the chemistry of vision, the significant thing is the almost parallel behavior of rod and cone thresholds during both the deficient and the recovery periods of the diet. This must mean that just as vitamin A enters into the chemical cycle of rod vision due to its association with visual purple, so it enters into the chemical cycle of cone vision, and that the cone sensitive substance[8]—iodopsin or visual violet—is very likely also a conjugated carotenoid protein like rhodopsin and porphyropsin.

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NEW OBSERVATIONS ON THE VITAMIN K DEFICIENCY OF THE CHICK

IN view of the interest shown in vitamin K by biologists and clinicians, it is believed that recent observations made in this laboratory should become available to other investigators.

It was found that vitamin K will bring about a normal clotting time of the blood of the vitamin K-deficient chick within from 4 to 6 hours after oral administration by pipette and that the blood clotting time of the chick will become abnormally long again within a short time, depending upon the amount of vitamin K administered.

Chicks were reared on a vitamin K-low diet for 3 days, then on the vitamin K-deficient diet E of Almquist and Stokstad[1] for from 10 to 16 days. When the typical hemorrhagic diathesis had appeared, the chicks were fed 0.20 ml of cod liver oil containing 1 mg of vitamin K concentrate No. 13[2] prepared from alfalfa. At 2 hours' intervals after the administration of the concentrate, the blood-clotting time of the chicks was determined by the method of Almquist and Stokstad.[3]

The blood-clotting time was found to be more than 30 minutes after 2 hours; after 4 hours, the blood of about 50 per cent. of the chicks clotted within 10 minutes; and after 6 hours practically all the chicks were normal with respect to coagulation.[4]

The coagulation time of chicks which had received 1 mg of the vitamin K concentrate remained normal for more than 24 hours; at the end of the second day, the blood of about 50 per cent. of the chicks no longer clotted within 30 minutes; and at the end of the third day, all the chicks had an abnormally long coagulation time.

No change was observed in the blood-clotting time of chicks which had received 0.25 mg of vitamin K concentrate No. 13 dissolved in 0.20 ml of cod liver oil. Only a small percentage of the chicks responded to 0.5 mg. The effect of 2 mg, likewise administered in 0.20 ml of cod liver oil, was found to last for more than 48 hours; but at the end of the third day, all the chicks showed an abnormal clotting time. The administration of 3 mg of the concentrate in 0.20 ml of cod liver oil kept the coagulation power of the blood normal in about 50 per cent. of the chicks for 72 hours; it was found that 3.8 mg of the concentrate dissolved in 0.20 ml of cod liver oil was necessary to keep the blood-clotting time of all the chicks normal for 72 hours.

Obviously the above observations can be employed as the basis for a quantitative biological assay of vitamin K. Such a method has been used successfully with several hundred chicks and will be reported in full in the near future. This method would seem to fulfill the requirements of standardization studies for which there is an actual need, as pointed out recently in a paper by Smith *et al.*[5] on the effect of bile and vitamin K on bleeding tendency and prothrombin deficiency.

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JUNE 29, 1938
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[1] H. J. Almquist and E. L. R. Stokstad, *Jour. Nutrition*, 12: 329, 1936.

[2] Unpublished data from this laboratory.

[3] H. J. Almquist and E. L. R. Stokstad, *Jour. Nutrition*, 14: 235, 1937.

[4] Since this paper was written, it was found that the clotting power of the blood of the vitamin K-deficient chick may become normal within 2½ hours after the feeding of a relatively high amount of the vitamin K concentrate.

[5] H. P. Smith, E. D. Warner, K. M. Brinkhous and W. H. Seegers, *Jour. Exp. Med.*, 67: 911, 1938.

[7] C. Edmund and S. Clemmesen, "On Deficiency of A Vitamin and Visual Dysaptation," Copenhagen, 1936, 92 pp.; C. Fridericksen and C. Edmund, *Am. Jour. Diseases of Children*, 53: 89, 1938.

[8] G. Wald, *Nature*, 140: 545, 1937; A. M. Chase, SCIENCE, 87: 238, 1938.

MATHEMATICAL EXPRESSION OF EQUILIBRIUM BETWEEN LIME, MAGNESIA AND POTASH IN PLANTS[1]

THE existence of a relationship between calcium, magnesium and potassium with respect to their absorption by plants has been suggested by many investigators. Loew[2] maintained that plants require a definite CaO/MgO ratio in their medium; Ehrenberg[3] enunciated his so-called "potash-lime law"; and Wiegner and Müller[4] deduced a relationship between calcium and potassium in the soil solution from conditions governing their equilibrium in the exchange complex.

The final truth, however, regarding the nature of the adaptability of the nutritive medium (soil) to the needs of the plant must lie in the mathematical description of the physiological processes within the plant itself. From this point of view, mathematical expression for the physiological relationships between certain elements ("entities") and plant response have been sought, expressible in terms of simple laws.[5,6]

In continuance of our investigations on foliar diagnosis[7] Plot 22, Tier 1, of the Jordan fertility field experiments has received since 1881 manure at the rate of 6 tons per acre applied to corn and wheat in a four-year rotation and has been limed at the rate of 2 tons per acre every four years. This treatment has given the highest yields on this Tier 1. In 1936 the yield of corn was 770.8 pounds per one eighth-acre plot. The plants on this manure plot, therefore, may be considered well nourished and near optimum for the soil and climatic conditions of this region.

In Fig. 1 is plotted in trilinear coordinates a magnitude designated the *CaMgK-unit,* representing the equilibrium between CaO, MgO and K_2O at the moment of sampling. It is derived by converting the percentage composition for CaO, MgO and K_2O of the third leaf into milligram equivalent (m.e.) values, and determining the proportion each of these bears to the milligram equivalent total. To avoid fractions, these values are multiplied by 100. The treatments indicated are of plants growing on the manure plot (Plot No. 22), together with six plots treated as follows: namely, nothing (Plot No. 1); nitrogen (Plot No. 2); superphosphate (Plot No. 3); potash (Plot No. 4); nitrogen + phosphate + potash (Plot No. 9); and lime (Plot No. 23). The numerals 0, 1, 2, 3, 4,

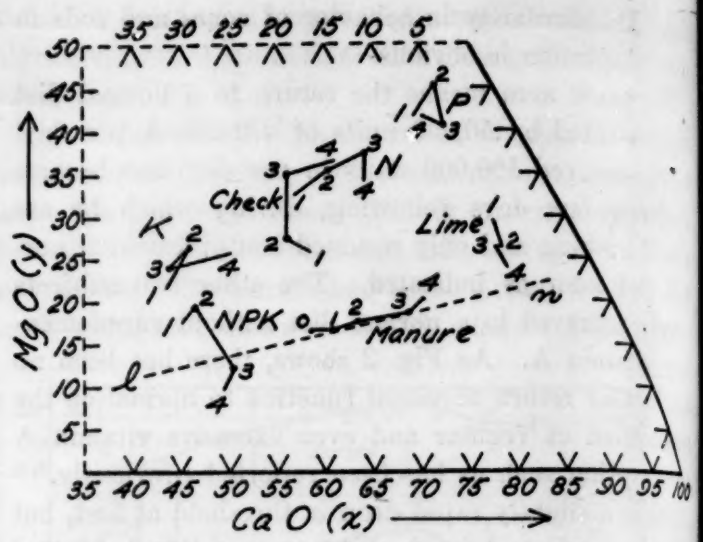

FIG. 1. Showing the deviations from the optimum physiological balance between lime, magnesia and potash in seven differently treated plots.

indicate the coordinate points for the dates of sampling, June 16, July 6, July 21, August 8 and August 25, respectively, in 1936. The straight (broken) line marked *ln* in Fig. 1 has been formed by joining the coordinates (see columns 1 and 2, Table I) for the values obtained at the second and fourth samplings, taken on July 6 and August 8, respectively, of leaves of the same metabolic age from plants growing on the optimum (manure) plot. *The equation of this line is* $y = 0.305\,x + 0.505$. The values from June 16 to August 8 lie sensibly on this line, deviation from which commences only at the last sampling date, August 25, with the incipience of chlorophyll degeneration.

Since, by our procedure[8] the sum of the values of any coordinate point $(x + y + z)$ is equal to 100, and inasmuch as $y = mx + b$, it follows that any two of these variables are related by a linear equation. The deviation of experimental values calculated from the above equation is shown in the last column of Table I.

TABLE I

EXPERIMENTAL VALUES AND VALUES CALCULATED FROM THE EQUATION REPRESENTING THE EQUILIBRIUM BETWEEN CaO – MgO, AT FIVE SUCCESSIVE DATES OF SAMPLING FOR PLANTS GROWING ON THE MANURE PLOT

Dates of sampling	Experimental values		Calculated values	Relative deviation
	MgO (y)	CaO (x)	CaO (x_1)	$\frac{x - x_1}{x}$
June 16 ..	15.600	50.245	49.492	+ 0.015
July 6 ..	16.561	52.632	52.632	0
July 21 ..	17.238	54.463	54.865	– 0.008
Aug. 8 ..	18.634	59.427	59.427	0
Aug. 25 ..	20.105	60.395	64.262	– .063

The yield of grain from the five unlimed plots are: nothing (Plot No. 1), 165.4 pounds; nitrogen (Plot No. 2), 265.5 pounds; phosphate (Plot No. 3), 371.2 pounds; potash (Plot No. 4), 298.3 pounds; nitrogen + phosphate + potash (Plot No. 9), 520.2 pounds;

[1] Authorized for publication as Paper No. 838 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

[2] Oscar Loew, *Flora,* 75: 368–394, 1892.

[3] Paul Ehrenberg, *Landw. Jahrb.,* 54: 1–159, 1919.

[4] G. Wiegner and K. W. Müller, *Ztschr. Pflanzenernähr. Düngung n. Bodenk.,* (A) 14: 321–347, 1929.

[5] H. Lagatu and L. Maume, *Compt. Rend.,* 179: 782, 1924.

[6] Walter Thomas, SCIENCE, 84: 422–423, 1936.

[7] Walter Thomas, *Plant Physiol.,* 12: 571–600, 1937.

[8] *Ibid.*

and from the limed plot (Plot No. 23), 452.2 pounds.

The deviation from the optimum (broken) line with respect to position, form and length between sampling dates shows in each case the nature of the disequilibrium between CaO-MgO-K_2O resulting from the different treatments.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

AN INEXPENSIVE SURFACE TENSIOMETER[1]

LLOYD and Scarth (SCIENCE, 64: 253, 1926) devised a simple and cheaply made tensiometer which combined the ring method of measuring surface tension with the essential mechanism of a chainomatic balance.

In our own laboratory we have made a few improvements on their device for measuring surface tension, improvements worth offering to instructors with classes too large for duplication of the excellent but comparatively expensive Du Nouy tensiometer. It is even possible that many research workers may find this apparatus in its improved form adequate for their needs.

The total cost of materials is less than one dollar if a nickel wire ring is made, and not more than three dollars if a standard platinum ring is purchased. Any chemist can build this tensiometer in a few hours.

The accuracy possible is rather astonishing. Readings within 0.1 dyne of the true values for pure liquids have been made by our own students.

The diagram will indicate the general features. Instead of using a single thin strip of bamboo for the balance lever (as advised by Lloyd and Scarth), we now obtain greater stiffness, and a desirable length with light weight, by connecting two bamboo strips, approximately 35 cm long, with two strips 5 cm long placed near the mid-point. The long strips of bamboo are bent sufficiently to permit tying together with strong thread or thin wire at the ends.

Between the two short bracing strips is placed a thin sheet of aluminum, approximately 0.7×3 cm, to serve as a fulcrum rest. The aluminum strip is twisted at the ends to grasp the short bracing strips of bamboo and is smoothly creased in the middle to give a resting place on the razor edge. We have considerably increased the delicacy of beam movement by using a safety razor blade as fulcrum. Of course this blade is firmly attached to the substantial wooden support (at the left). A strip of metal, bent at a right angle and perforated for two screws, makes a good support. Two very light wire hooks are attached to the ends of the beam or balance arm—one as support for the wire ring and the other as point of attachment for one end of the chain.

The ring may be purchased or shaped from platinum or nickel wire (24–28 gauge) by bending around a glass tube of approximately 1.3 cm diameter. Of course, a length of this wire extends almost vertically about 3 cm as a "handle" or arm of the ring. A small loop shaped at the end permits the ring to swing freely from the end of the beam. Platinum rings are best, yet nickel rings are almost as good. It is not difficult to weld two platinum supporting wires to meet above the ring.

In our laboratory we have found the light aluminum chain attached to ten-cent jewelry (Woolworth's and others) to be very suitable for this tensiometer. This chain is extended in length with a piece of strong thread which passes through a small metal ring (or screw-eye) near the top of the vertical board. Near

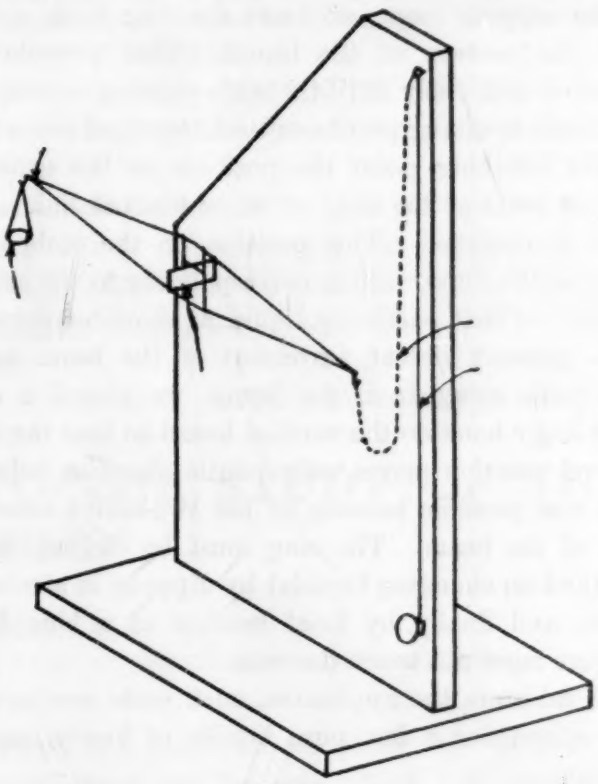

FIG. 1

the bottom of the board this thread is wound around a wooden cylinder (half of a common spool or a wooden drawer knob) so attached to the board that it turns stiffly when desired. The smaller the links in the chain the more accurate the readings.

After trying various lengths of beam to secure the best combination of lightness, stiffness and accuracy, we decided that a length of about 35 cm was most desirable.

The wooden support for the moving parts consists of two common boards nailed together at right angles, as shown in the diagram. A maximum height of 55

[1] Several students have offered useful suggestions, notably Malcolm Keiser and Croom Beatty.

cm allows sufficient movement of the chain, and a width of about 27 cm is suitable for the vertical board. A coat of shellac prevents warping.

The dish containing the liquid for surface tension measurement is most simply held in the hand, but is best supported at the proper level for greater accuracy with an adjustable platform.

A graduated scale (sheet of graph paper) on the supporting board makes it possible to record accurately the changing positions of the end snap or any other marked link in the aluminum chain. To make a reading the beam is leveled so that the end at the right (with projecting wire pointer) points directly to a "rest mark" or heavy line appropriately drawn on the sheet of graph paper pasted on the board. The clean vessel of liquid is raised until contact is made with the ring and the chain adjusted so that there is no pulling away from the liquid. If ethanol or other liquid of low surface tension is to be used, the chain must be pulled up rather high before releasing the beam. The chain is lowered cautiously until the increasing weight of the sagging loop just tears the ring from contact with the surface of the liquid. This procedure is repeated cautiously until the scale reading corresponding to the breaking point can be determined accurately. At the breaking point the position on the arbitrary vertical scale of the snap or other marked link of the chain is observed. This position on the scale is set down as the scale reading corresponding to the surface tensions of that particular liquid, at room-temperature.

To prevent violent movement of the beam as the ring pulls away from the liquid, we placed a small right angle hook on the vertical board so that the beam in level position moves only a little above or below it. This was possible because of the two-splint construction of the beam. The ring must be cleaned before use (and on changing liquids) by dipping in alcohol, in water, and finally by brief heating in a blue flame. Fingers must not touch the ring.

To calibrate the apparatus, such scale readings are determined for a few pure liquids of known surface tension.

To illustrate the application to an unknown, we offer the "key" diagram for one particular tensiometer built by a student. A sheet of graph paper pasted on the vertical board serves as scale and permits plotting of a reference curve. On the horizontal axis is a scale of surface tension values in dynes, while on the vertical axis is an arbitrary scale of such units as are read with this particular tensiometer. For seven pure liquids, points on coordinate or graph paper were plotted in accordance with scale readings, and true surface tension values (corrected to the temperature of operation) obtained from reference books. In actual practice with this particular tensiometer, these seven points

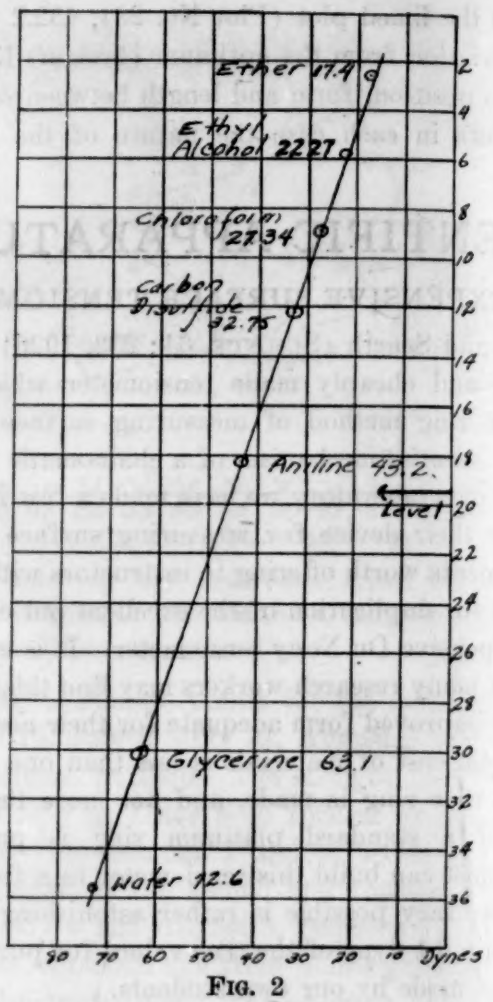

FIG. 2

were connected with a single straight line—excellent confirmation of accuracy.

After determining the scale reading for an unknown, as 22.5, for example, a glance at the diagram indicates a corresponding surface tension value of 50 dynes.

(Excellent detailed instructions for use of the Du Nouy tensiometer are found in Bulletin 101, printed by the Central Scientific Company of Chicago. An elaborate chainomatic tensiometer is sold by the Arthur H. Thomas Company of Philadelphia.)

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BOOKS RECEIVED

BROWN, HARRY B. *Cotton; History, Species, Varieties, Morphology, Breeding, Culture, Diseases, Marketing, and Uses.* Second edition. Pp. xiii + 592. 140 figures. McGraw-Hill. $5.00.

COWDRY, E. V. *A Textbook of Histology; Functional Significance of Cells and Intercellular Substances.* Second edition. Pp. 600. 323 figures. Lea and Febiger. $7.00.

HOGG, JOHN C. *An Introduction to Chemistry.* Pp. xiv + 365. 115 figures. Oxford University Press. $2.00.

MESSER, HAROLD M. *An Introduction to Vertebrate Anatomy.* Pp. xvi + 406. 374 figures. Macmillan. $3.50.

ROGERS, CHARLES G. *Textbook of Comparative Physiology.* Second edition. Pp. xviii + 715. 158 figures. McGraw-Hill. $5.50.

WEISNER, LOUIS. *Introduction to the Theory of Equations.* Pp. ix + 188. 16 figures. Macmillan. $2.25.